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PREFACE

By J. C. WILLIS, M.A., Sc.D., F.R.S.

One who is unfamiliar with the carrying out of agricultural experiments does not always realize the difficulties that face the experimenter nor the great slowness with which he must expect to proceed in arriving at results that are of real and permanent value. In this preface an attempt is made from this point of view to deal with the reports from the Experiment Stations—reports which the average man engaged in other occupations can hardly find the time to study as they deserve—pointing out some of the obstacles to rapid progress, the objects which are aimed at, and the degree of success that has as yet been arrived at in their pursuit.

A paper in the January number of the *Review*, by Mr. Youngman, shows how the yield of cotton falls off as the rainfall departs from the average (or what is sometimes called the normal, though in actual fact it rarely occurs). Thi sdeparture of the rainfall from the average, occurring as it does in practically every season, forms one of the greatest physical difficulties with which the experimenter has to contend, for if the variation from average be at all serious, not only is the yield much reduced, and more difficult to obtain, but other difficulties may appear—as, for example, stoppage of opening of bolls (p. 3); sprouting of seed; sappy growth (liable to shrivel in dry weather afterwards) (pp. 34, 35); attacks of pests and diseases; reduction of plots by erosion; cutting short of the experiment by extreme conditions (p. 72); and so on. A valuable series of experiments may be quite cut short, or progress retarded for a year.

An examination of the reports brings this difficulty out very clearly. If we look at the climatic records of each station for this and for the preceding year, we find that roughly five of the whole twenty seasons were what may be called good, ten medium, and five bad. This is a very rough estimate, but goes to show that perhaps one season in four or five will be good. The obstacle is a formidable one, which cannot in general be overcome at present, for one cannot easily set about breeding plants suited to greater variability of climate than those cottons already in existence, which are in reality wonderfully adaptable. Slight side attacks upon the problem may indeed be made, as with the planting of wet seed (p. 9), which may

germinate better, especially in a season with late (but not too late) rains.

Climates that, like all cotton (or other) climates, are merely sometimes too wet and sometimes too dry, must not be confounded with those climates whose *average*, or whose distribution of rainfall, is definitely somewhat above or below the best for cotton, so far as, from experience of other climates, one can say what is the best. The ideal climate for cotton will vary in total rainfall necessary according to the amount of wind, sunshine, etc., but in general one may regard it as one in which the rains begin promptly at a definite period—the same from year to year—and rapidly bring the soil to a condition in which the moisture content is about 25 per cent., so that the seed sown will germinate rapidly and well. The rains must then go on for some months at such a rate as to keep the soil always at something less than this degree of dampness, until the plants are fully grown and beginning to flower. The rains must then gradually diminish in quantity and be succeeded by a finer and more sunny period of some months in which to ripen the seed. During this period, while slight or gentle rain at times will be of distinct benefit, it is important that there be no heavy and unseasonable storms with much rain, which would result in the dropping of many unripe bolls, and the matting of the cotton in ripe ones.

One or two of the climates in which experiments are being made seem as if they might be included in the category of too wet or too dry; and in such cases the breeding of varieties that will suit the conditions better than any that already exist is quite within the realm of possibility. An example of work of this kind is given under Fiji (p. 267), where the rainfall perhaps tends to be a little on the high side, and where an attempt is being made to obtain a good local variety from some kidney cottons imported from New Guinea (also a wetter climate) by Mr. Evans. The objection to a kidney cotton pure and simple is the adherence of the seeds, and a satisfactory variety must have its seeds free. To this object the breeding work is being directed, and the Report (p. 268) shows that success appears to be within sight, for both K.3-2 and K.8-2 seem to have lost the coherent character. If these races, as appears to be the case, are good in their other characters (of lint, etc.), and breed true, then as soon as they can be multiplied up, Fiji will have been supplied with a cotton that appears to be both suited to the local conditions and of good quality.

Work of the same kind is going on to a greater or less extent upon most of the Experiment Stations, while at the same time the

most obvious first work of such a station—thoroughly to test the possibilities of existing varieties from different regions where cotton is grown—is being carried on with vigour. See, for example, the work described under Uganda (p. 196). A perusal of this will give an idea of the ways in which varieties may prove to be unsuitable, at the same time indicating the directions of breeding that may prove to be the most remunerative.

In some cases, for example in South Africa, the first survey of the whole problem may indicate at once the direction towards which breeding and selection must work. In that country it was already known that no variety that had yet been tried from elsewhere was insusceptible to the most disastrous attacks of the jassid pest. So troublesome was this insect, that until it was in some way brought under control, cotton could not possibly be a profitable and widespread commercial crop in most parts of the country. The whole resources of the Experiment Stations were at once turned to dealing with this pressing problem, and in a wonderfully short space of time it appears to have been solved in a great degree by the production (p. 35) of three varieties—U.4, A.12, and Z.1—that are to a very large extent indeed immune to jassid, and which at the same time (and this is one of the great difficulties that often crop up in breeding work, and which has also been successfully solved in this case) show (p. 36) good characters of lint and other desirable features. This question is dealt with in greater detail in Mr. Milligan's report (pp. 31-3), which should be read in this connection. On account of the urgency of dealing with the jassid problem, the strains mentioned, though the work of their improvement is as yet by no means complete, have been, and are being, multiplied up as rapidly as possible for general distribution. This will afford relief to the primary problem—jassid—of cotton cultivation in a large part of South Africa, and enable the Experiment Stations, while still devoting much time and labour to jassid, to spare some for the many other problems that confront them. The results already attained in South Africa form a distinct triumph for the work of the Corporation.

At the Gatooma Station, which begins to be a little outside of South Africa proper, though still within the zone where jassid is troublesome, a good deal of the work was devoted to a study of the behaviour in that region of the jassid-resistant strains produced at Barberton, and especially to U.4 (p. 126). It would appear from this that they are just as likely to do well in Rhodesia, which is distinctly fortunate, for besides being jassid-resistant, U.4 produces a large yield of very good cotton. In this connection Mr. Cameron's

introductory note (p. 109) should be read. Breeding and selection of the strains of Cambodia cotton previously introduced were also carried on steadily, and some of these seem quite promising, being highly jassid-resistant and giving good yields.

The improved jassid-resistant strains produced at Barberton are also being tried on all the stations within the zone of jassid in Southern Africa, and seem to retain their useful character in whatever place they may be planted (pp. 59, 98, 114). As these stations are also themselves at work upon the further improvement of these strains, there seems every hope that before long jassid may cease to be the limiting factor that it has hitherto been in Southern Africa.

To obviate the jassid difficulty is a great success, but it is after all only the beginning of a never-ending series of ameliorations that must be made if cotton cultivation is to succeed and expand; and it is of interest to notice in the work of the South African stations that in spite of the pressing urgency of the jassid question, progress is being made along other lines. Especially is this the case with regard to bollworm, and both the Experiment Station at Candover (pp. 32, 82) and the stations kept up by the Government have lately discovered parasites that prey upon this insect, and which may come to play a very important part in its reduction later on.

The various bollworms are probably, taking cotton in the world as a whole, the most injurious pests next to the boll-weevil, which is as yet confined to the United States and Mexico. The bollworm occurs in practically all cotton countries, and the attack upon it by various methods, or the breeding (if such be possible) of resistant varieties, consequently forms an important part of the duties of most Experimental Stations. Nearly all the reports contain statements and reports of bollworm incidence, methods of attack upon the problem, and so on.

In Queensland, for example, the history of pink bollworm is best read in Mr. Ballard's report for the previous year (Experimental Stations, 1926-7, p. 36). With careful quarantine inspection of imported seed, disinfection of seed, destruction of old plants, etc., it seems as if the pest would be sufficiently well kept in hand (ditto, p. 37), and as corn-ear worm and other insects were more really injurious, more attention was being given to them.

Turning now to South Africa (p. 76), we find a country in which bollworms are more serious, though much less so at present than jassid. Various experiments upon different methods of attack are described—*e.g.*, light trapping (p. 77), which seemed quite promising, and the use of trap crops (p. 83), which also looked as if it might

be fairly successful. In Swaziland (p. 107) bollworm attack was but slight, so that it was not possible to say whether the trap crops used were really successful or not. At Gatooma, Southern Rhodesia (p. 123) attack was also slight. In Nyasaland a general policy has been adopted of regarding insect attacks as indicators (pp. 219, 243), so that attempts at direct control of bollworm in the experiments have been dropped, though weekly records were made. Mr. King in his report (p. 250) on the entomological work states that light trapping is proving very effective. Finally, in Fiji (p. 275), it is reported that damage was slight, the pest being apparently kept in check by parasites. When, as indicated above, the parasite method shall have been properly studied and initiated,* it may be hoped that it, combined with quarantine inspection and disinfection, as in Queensland, and light trapping, etc., as in Africa, may enable people to keep the bollworm pests to a minimum degree of incidence. Breeding may also come into requisition at some future date.

Another very widespread and troublesome phenomenon in cotton cultivation in any part of the world is the shedding of immature bolls, generally known as boll-shedding, though as flowers and buds are also very often shed, it might perhaps be better to call it simply shedding, specifying when necessary what is shed. This seems to occur both when the soil becomes unseasonably damp, and still more when unseasonably dry, and is probably due to many causes. At Candover (p. 71) shedding records were taken with reference to spacing, and showed that it was greater with closer spacing. Records at Gatooma (p. 115) show that the boll-shedding curves closely follow the shape of the flowering curves, with a lag of eight to nine days. In Uganda (p. 195) a definite attempt to breed varieties with reduced boll-shedding is being made, and out of sixty-three strains grown in progeny rows, two—S.G. 23-8 and S.G. 21-5—originating from the Nyasaland Upland variety in 1924, have been isolated as giving considerably lower boll-shedding rates than the rest. The first named is the better as having large bolls and good lint, and is now being multiplied up for more extended trial. Other strains are also under experiment.

Other lines of breeding work are in progress upon various of the Experiment Stations. In Nyasaland (pp. 221, 236), for example, in addition to the work on jassid-resistant strains, and the general trials of varieties, a great deal of work has been done on the further improvement of local strains of Over-the-Top cotton, which seems in some ways the most suitable variety for general use in the higher

* See Empire Cotton Growing Review, V., p. 113, and VI., p. 80.

parts of the country, as well as on strains of Durango, Cambodia, and other types. As in South Africa proper, jassid-resistance seems indispensable here, and this fact distinctly limits the selection at present possible.

Attempts to improve staple and yield are being made in Uganda (p. 197). In the Sudan (p. 143) an extensive series of variety trial and breeding experiments is in progress, the general principles of which will be better understood by reference to the reports for the preceding year (1926-7, p. 148). Two sets of experiments—Egyptian cotton under irrigation, and American under irrigation and under rainfall—are being carried on, and careful environmental and developmental records kept. In addition to this work upon varieties already known elsewhere, much definite breeding work, with testing so far as possible of the resulting strains, is going on, with a view to obtaining good local strains with good lint characters, high ginning outturn, and good resistance to boll-shedding. A summing up of the strains under trial is given on p. 144. It is felt as the result of both these lines of work that definite progress has been made towards supplying a type of cotton which will be specially suitable to the zone of medium rainfall of the Southern Sudan, and efforts will now be directed towards selecting a type suited to the conditions of the far south.

In Queensland bulk selection—taking all the better plants of the crop—is going on as well as progeny row breeding, and is accompanied by careful "roguing out" of undesirable characters. A distinct improvement is being shown in the resultant seed, and it is hoped in future to distribute only improved seed.

In general, and having in view a really extensive development of cotton cultivation, it is hardly going too far to say that an imported variety from elsewhere will only rarely turn out to be the one absolutely best suited to the local conditions of soil, climate, attacks of pests and diseases, etc. It will usually not be found impossible (though the work is slow) to get strains better suited to the local conditions, sometimes by hybridization of existing forms, but more often by careful selection from them of individual plants showing the desired characters in greater or less degree. Such plants, selected from generation to generation, will be more likely to give good results under the local conditions.

But merely to breed improved cottons, or to find the variety best suited to the local conditions, is by no means to solve the problem of making cotton an important commercial crop in any given country or locality, though it will contribute very considerably towards that

end. There are many other factors at work in the matter. For example, it is of the very highest importance to reduce as much as possible the actual cost of production, inasmuch as reduction of the cost of transport, which is a very serious factor in the problem, is at present very difficult on account of the time and expenditure that are required in the construction of new railways, roads, and the like, and does not in any case come into the work of an Experiment Station. Reduction of cost must at present lie chiefly in improved efficiency of cultivation, etc., and experiments in this direction are in progress at most or all of the Experiment Stations.

In Queensland, for example, a very suitable (external) variety having been discovered, which is quite good enough for the early stages of the industry, a great deal of work is being devoted to matters that have to do with the improvement of methods of cultivation, etc., Australia being a country of rather high labour costs. Experiments are in progress here, as at many other of the Experiment Stations, that deal, for example, with the best time to plant, the best direction of the rows with reference to the sun (whose incidence is by no means always the same at the same time of day in all countries), with the height to which it is economic to allow the plants to grow before thinning, and with various other problems of this kind, including the use of wet rather than dry seed, already referred to above (p. v).

In South Africa the chief experiments of this kind that are in progress relate to the best spacing to allow between the plants, to the best times of planting, systems of manuring, etc. And in both countries, and on several other Experiment Stations, the very important question of rotation of crops is receiving a full measure of attention. It is of great importance from every point of view that cotton—which is grown as an annual crop—should not form the only crop on the land year after year, but that it should form a member of a definite rotation of crops devised in such a way as to get the full value out of the soil (with any manures that may be added), while at the same time returning to the cultivator the greatest possible financial benefit for the smallest possible expenditure of work. It is clear that to devise such a system will call for a great expenditure of work upon the cultivation (in all sorts of combinations) of many different crops over a good many years, but already many of the Experiment Stations have done, and are doing, valuable work in this direction. In this connection Mr. Milligan's remarks should be read (pp. 32-3).

The cotton plant, being a member of the family Malvaceæ—a widespread family including many common weeds, and with a well-

marked individuality which perhaps indicates a considerable degree of resemblance in chemical features also—is subject in the highest degree to the attacks of insect pests, and is also liable to several important fungus diseases. Malvaceæ being so common, and often so similar, it is often easy for a pest of cotton to find some other host when cotton is not growing, and this fact further complicates the subject. A considerable part of this volume is taken up with notes upon these pests and diseases, their effects, and means of combating them. The brilliant results of the campaign against jassid have already been referred to, and so have the bollworms and some others. But there are other pests which form very important handicaps to successful cultivation in one or more countries, and some reference is required to work that is being done in this connection.

Take, for example, the cotton-stainer (Dysdercus), which is a major pest in a good many countries. Work upon this pest has been done at Candover (p. 73), where counts of damage were made; at Gatooma (p. 120), where good results were obtained by trapping and by hand picking; at Makwapala, Nyasaland (p. 223), where the station was found to be infected from some considerable distance away; and at Port Herald, where it was thought that trapping might prove useful, and where some strains of cotton were found more resistant than others. All this indicates very clearly how many sides there are to any problem, even though at first it may appear quite simple and straightforward, and how ultimate and more or less complete success will probably depend upon judicious combination of all discovery.

Other work was done in various of the Experiment Stations in regard to thrips, cut-worm, corn-ear worm, cotton-leaf beetle, and various others of the great number of pests that attack cotton.

Finally, mention must be made of the valuable work being done at the Corporation's Seed Farm at Daudawa in Northern Nigeria, a farm started two years ago to aid the Department of Agriculture in that country in the mass multiplication of their selected seed. During the past year 170 acres were under cotton, and large quantities of seed were produced for distribution, while at the same time useful work was done upon the improvement of methods, rotation of crops, and other matters. This station should soon prove of great value in the extension of cotton cultivation in Nigeria, a country which has great undeveloped potentialities in this respect.

QUEENSLAND

REPORT ON THE WORK OF THE CALLIDE COTTON RESEARCH STATION, BILOELA, FOR THE YEAR ENDING JUNE 30, 1928

BY

W. G. WELLS.

Introduction.—The programme of work carried out for the past season has been along the lines which have been outlined in the previous Annual Reports of the Station. Generally speaking, satisfactory progress was made in the development of the Station and in the conduct of the series of experiments that are being tried.

Seasonal Conditions.—The seasonal conditions for the crop under review have differed, in many respects, from any that have been experienced since the establishment of the Station. A total of 3·67 inches of rain falling in June, and 1·10 inches in July, gave ample moisture to allow of the preparation of an excellent seed bed as soon as the old cotton crop was destroyed. A fall of 0·7 inch on September 11 followed by a total of 0·75 inch on the 28th and 30th of the month, gave favourable planting conditions on which excellent germinations were obtained. Further rains in October assisted in establishing the " strike " obtained, so that, as a whole, the stand of seedlings was satisfactory, although some irregularities occurred in a few of the experiments. November was somewhat dry and hot until the end of the month, when 1·68 inches fell. This came at a welcome time, as the plants had received sufficient checking in their development, and further absence of rain would have resulted in a severe cessation of growth. Unfortunately the usual heavy December precipitations were not experienced, the total of 3·49 inches being spread over thirteen wet days, the greatest fall being 1·29 inches on the 27th of the month. Somewhat similar conditions existed during January, the total of fourteen wet days amounting to 5·15 inches, the greatest of which was 1·17 inches on the 29th; and again in February, when twenty-one wet days yielded a total of 7·02 inches.

Normal harvesting conditions developed during March, but were broken in mid-April by a most unusual cyclonic storm in which 8·72 inches occurred in five days. Fortunately the Station received

only the outer edge of this storm, as the centre, some 50 miles away, experienced 43 inches in the same time, resulting in widespread floods of severe intensity, accompanied by loss of human life, livestock, and crops. The usual dry bright weather of May set in after that and continued on through the rest of the harvesting season, with the exception of light storms at several periods in June, when a total of 2·57 inches occurred. The first frosts occurred on May 13, 14, and 15, when temperatures of 30°, 28·3°, and 30·5° respectively were experienced, followed by another frost of 30·5° on the 18th.

Cotton.

Satisfactory yields of cotton were obtained from most of the plots with the exception of the H. block* and the Eastern borders of I., J., and K., where a Corn Ear Worm attack from a neighbouring cotton farm caused severe damage. As has been stated, the splendid condition of the seed bed and the early rainfall generally allowed of excellent stands being obtained on all plots with the exception of H. block and borders K. 9 and 10. The reason why a poor stand was obtained in H. block is not clear, but it is suspected that the seed bed may have been of too open a nature following the late turning under of a heavy crop of cowpeas. Planting with too light a rate of seeding in an attempt to spread a small amount of pedigreed seed over too large an area explains the poor results obtained in the K. borders.

The excellent growing conditions in October caused a somewhat luxuriant growth of the seedlings which really required the dry, hot conditions of November to check them sufficiently to form a proper fruiting structure. The rain on November 28 was of just the nature to start the development of an excellent type of plant in most of the normally grown plots. The absence of further good "growing" rains during December checked the plants from fulfilling the excellent November prospect of very high yields. The showery weather through January did not rectify the situation much, the plants making only slow growth of a somewhat succulent nature. Any periods of high temperatures and dry, sunshiny days caused rather severe drooping of leaves, tender new fruiting branches, and squares. Similar conditions continued on through February, although considerable relief was afforded during the wet period in the middle of the month.

The setting of bolls was surprisingly heavy in such conditions, but their general size was decidedly smaller than is usual on the

* See plan, "Reports received from Experiment Stations, 1926-27," p. 8.

Station. This condition might have been improved if heavy rainfall had been received in March, but the one storm, of 1·39 inches on the 9th, was apparently only sufficient to carry the bolls on to maturity.

A marked irregularity of growth of the different parts of the plants developed under such conditions, a general shortening of the internodes of the main stalk and of the fruiting branches occurring at corresponding zones on the plant, in most of the different plots. This was especially true of the bolls and largely explains the relatively high percentage of short fibres which were present in the majority of the consignments of cotton received at the ginneries from most of the different districts.

As would be expected, the crop matured early under such conditions and picking was generally being carried out on most farms in the adjacent district by the end of March. Plots on the Station by mid-April had yielded up to 1,700 lbs. of seed cotton, which would indicate at least a month in earliness of maturity as compared to the previous season.

The very unusually heavy rainfall of 8·72 inches in mid-April completely stopped the opening of the crop on nearly all of the plots. When the first frosts occurred twenty days later, plants which were picked just prior to the rain had failed to open an average of two bolls per plant. Not only was the opening of the bolls checked, but the amount of moisture in them was so excessive that a temperature of 28·5° F. froze them so severely that they only partially opened. This was in marked contrast to previous seasons, when such frosts were welcomed as they hastened the opening of the dry, hard-skinned bolls so that the crop could be harvested in one final clean-up. The result of the combination of excessive moisture and killing frosts was to cause the loss of a large top crop of medium-sized bolls which, under ordinary conditions, would have contained fibres of sufficient length and strength to be of good commercial quality.

Much of the cotton was unpicked when the rains occurred, and as there was no sunshine for four days, the seed in upright bolls sprouted to such an extent as to make much of it worthless for planting purposes.

Cotton-breeding.—No " bulk " or " mass " selection operations were conducted in the breeding plots of this season. The mid-April storm came just when the work was about to start, and owing to the very large amount of seed which sprouted in the bolls, it was not considered that a sufficiently high percentage of good seed would be obtained to warrant the usual programme of work being carried out. It was also considered that the characters of the fibre would be so

badly affected that their true nature could not be determined. The plot was accordingly picked in bulk and sufficient seed was saved to allow of the sowing, at a very heavy rate, of another plot during the coming season.

A representative sample was taken from this seed and examined in a manner similar to that used last season with the seed obtained from the bulk-selected plants. Out of 5 lbs. 5¼ ozs. of seed, a total of 2·2 ozs., or 2·57 per cent., of off-type seed was removed. Owing to the seed having been treated on a gin which was set to gin the seed closer than was the one used in the previous season, no account was taken of partially naked seed, as it was obvious that much of such seed had been " delinted " by the saws. Thirty-three greenish-grey seeds were noticed, but no dark green, heavily fuzzed ones such as were found on four plants in the roguing operations of the previous season. Taking the seed as a whole, it appeared to be of a much more uniform general type than the lots of the previous seasons. When it is considered that this seed was representative of many plants, whereas the seed examined in the previous season was from 240 selected plants, it is believed the results obtained indicate that material progress has been made in developing a bulk lot of seed of good commercial uniformity.

One boll per plant from corresponding sections of 100 consecutive plants was collected for fibre-length examinations. Combed samples of one seed per boll indicated that a much greater degree of uniformity of length of staple was present than existed in the samples of ordinary commercial seed cotton examined in the previous season. Unfortunately, similar material was not available from a crop grown on comparable soils in this season, so that a direct comparison could not be made. It is believed, however, that a marked improvement in the degree of uniformity of length and character of the fibre has been obtained.

Progeny Investigations.—The usual plant-to-row method of investigation was continued during this past season. No outstanding results were obtained, however, in the progeny block. Several progenies were of satisfactory uniformity of type and lint characters, but unfortunately did not possess the proper staple length. One promising progeny was obtained, however, which will be increased under isolated conditions. Several new selections were made in the bulk plantings, and in those passing the final laboratory tests; the outstanding feature appeared to be the exceptional strength of the fibres. The promising progeny strain which was mentioned in the last Report was increased this season in a commercial planting. An

examination of the crop showed, however, the existence in this strain of a very undesirable tendency to throw out a big-bolled off-type plant with greenish seed and short fibres. The same characteristic appeared in several progenies from the parent plot of this planting, and it is consequently being dropped from further investigations.

Cotton Experiments.—Most of the cotton experiments that are being conducted at the Station deal with problems which require several seasons' repetition before any conclusive results may be anticipated. In dealing with the results obtained in experiments which have been described in previous Reports of the Station, a full description of the method and the general reasons for the experiment have been omitted. Such experiments are marked with an asterisk (*) to indicate that they have been described more fully in the Annual Reports of the Callide Cotton Research Station of 1925-26 and 1926-27.

*Fallowing Experiment.**—This experiment consists of a comparison between the following systems of cotton-growing:

(*a*) A cotton crop following a cotton crop of the previous season.

(*b*) A cotton crop following a fallow from late summer until planting time—the fallow to be preceded by a summer fodder crop (giant panicum).

Unfortunately an uneven stand of plants was obtained in the two plots of this experiment, so the results are not strictly comparable. The plant growth in the two plots was more or less similar throughout the first portion of the season, but following the December rains a slightly more vigorous vegetative development occurred in the long-fallowed plot. A corn ear worm attack in the early squaring stage of the plants further complicated the results obtained. The following table gives the number of plants and the yields on an acre basis.

YIELDS IN THE FALLOWING EXPERIMENT.

Treatment.	*Number of Plants per Acre.*	*Yields per Acre (lbs.).*
Cotton following cotton	5,059 ± 69	1,430 ± 29
Cotton following fallow following summer fodder crop	4,367 ± 56	1,183 ± 44
Difference	692 ± 89	347 ± 53
Significance of difference	$\frac{D}{E}$ = 7·8	$\frac{D}{E}$ = 6·5

It can be seen that an appreciable error in the number of plants per acre was present. An examination of the row-yields failed to show any correlation between number of plants per row and yields —the correlation ratios being respectively 0·35 and 0·25. However, the number of plants in the lighter yielding plot approximated only 86 per cent. of the number in the other plot and the yield was around 83 per cent. It would appear, therefore, that the irregular stand materially affected the results. Counts of three-quarter-grown bolls were made on thirty consecutive plants in adjacent rows of each plot, but no significant differences were obtained, so the stage of maturity of each crop was apparently the same.

As a check on the results of this experiment, the data from an adjacent plot in which Sudan grass had been grown in 1926-27 were compared with the cotton-following-cotton plot. The cotton crop in this plot was planted and cultivated in conjunction with the experiment. Unfortunately the ploughing after the Sudan grass was harvested was made on June 7 as compared with April 5 for the giant panicum plot, so the early treatments are not comparable. The cotton plot was not ploughed until July 19, and as the June 7 ploughing followed 3·63 inches of rain, it is believed that some difference existed in the amount of subsoil moisture conserved. The yields of these two plots are as follows:

Table of Yields.

Treatment.	*Number of Plants per Acre.*	*Yield per Acre (lbs.).*
Cotton following cotton	5,059 ± 69	1,430 ± 29
Cotton following fallow following Sudan grass	4,692 ± 88	1,377 ± 26
Difference	367 ± 1·12	53 ± 39
Significance of difference	$\frac{D}{E}$ = 3·24	$\frac{D}{E}$ = 1·36

The results of this comparison would tend to confirm the idea that the irregularity of stand in the proper experiment was the chief contributing factor in obtaining such a large difference between the long-and-short-fallowed plots. It would appear, therefore, that no gain in yield had been obtained by planting on the long-fallowed plot. The unusual amount of rainfall during the early stages of plant growth may explain such a result.

*Time of Planting Experiment.**—It was possible this season, for the first time since the Station has been established, to obtain a planting in each of the spring months. Good germination occurred in all plots and comparable stands were obtained. Unfortunately the November planting was nearly three weeks later than in any of the previous seasons, so that the results of this part of the experiment will not be comparable with those of past seasons. The heavy fall of rain in mid-April further affected the yields, especially in the October planting, where a heavy crop of nearly matured bolls was badly frozen by the frosts of May 13, 14, and 15.

The plants in the September sowing made a very slow growth under the prevailing conditions of low minimum soil surface temperatures, so that the thinning operations were not performed until October 26, when the plants averaged about 6 inches high. The occurrence of rains at this period gave the necessary stimulus for the production of a good fruiting system. Squaring was general by November 14, and flowering commenced on December 3. A good crop of bolls was set by mid-January which assisted in controlling the growth of the plants sufficiently to check the tendency to excessive vegetative development caused by the late December rains. Some shedding occurred in the late January dry spell, especially on the fruiting branches borne on the vegetative limbs. A showing of open bolls was present by February 12, and the first picking was made on April 2. A good crop of bolls for a second picking was in evidence at the time, but was not obtained owing to the effect of the excessive moisture conditions followed by the May frosts.

The October planting was made on October 5 following the occurrence of good rains. Steady growth was maintained and thinning was effected on November 7. A severe loss of terminals occurred during the seedling stage, through the attacks of an insect suspected by the Cotton Entomologist to be *Thrips tabaci*, which was present at the time. By November 26 a good showing of squares could be seen. Slight attacks by corn ear worms* were being experienced at this period. Flowering was starting by December 16. A greater amount of vegetative development was made following the December rains than was the case in the September planting, and severe losses occurred in the resultant large crop of young squares during the heat wave of late January. A good recovery was made in early March following the late February rains, but further losses were experienced in the heat wave in late March. The bolls were opening well by March 10. Unfortunately the heavy April storm

* *Heliothis obsole*

occurred before this border was picked, so that some loss of weight may have occurred through the sprouting of the seed. A heavy crop of over-half-developed bolls was badly frozen by the May frosts.

The November planting could not be planted until the 30th of the month. No terminal damage was experienced in this plot, but an excessive vegetative development resulted which bore only a light crop. Squaring was general on January 7, and flowering commenced on February 1. Severe losses of squares occurred in the January and March heat waves. The excessive amount of moisture following the April storm undoubtedly delayed the maturing of the crop, as the first bolls did not start opening until May 20 after the occurrence of the frosts.

The December planting was made on the 21st of the month and developed a very excessive vegetative growth for plants of medium height. The fruiting branches were short and bore only a few bolls per plant. Squaring was general by February 28, and flowering by March 23. The first bolls opened by June 3.

Flower counts of equal row lengths in the September, October, and November plantings gave clear evidence of the tendency to earlier fruiting in the September planting. In a section of each plot representing $\frac{1}{22 \cdot 857}$ acre, the following counts of flowers were obtained:

Planting.	*Counts to January 31, 1928.*	*Rest of Season.*	*Total.*
September	5,186	6,057	11,243
October	4,307	6,782	11,089
November	—	2,426	2,426

The yields per acre are given below for the four plantings, as well as the results of the experiment for previous seasons.

TABLE OF YIELDS IN TIME-OF-PLANTING EXPERIMENT.

Season 1924-25.

October 7 planting	912 lbs. per acre.
November 10 planting	855 „ „ „
December 19 planting	220 „ „ „
January 15 planting	not picked; failed to mature.

Season 1925-26.

No October planting.*	
November 5 planting	933 lbs. per acre.
December 15 planting	116 „ „ „

* No October planting was obtained in the experiment. Plantings in mid-September on the station produced from 922 to 1,473 lbs. per acre.

Season 1926–27.

October 2 planting	1,071·5 lbs. per acre.
December 22 planting	No yield; failed to mature.

Season 1927–28.

September 12 planting	1,754 lbs. per acre.
October 5 planting	1,189 „ „ „
November 30 planting	207 „ „ „
December 21 planting	157 „ „ „

The results of the experiment are in keeping with those of previous years, and with the general results obtained by the cotton-growers in the surrounding districts. Not only does it appear that heavier yields may be obtained by planting early, but a fair degree of immunity from the attacks of corn ear worm is usually secured. Some cases of rather serious invasions of early-sown crops by this pest from adjacent standover crops occurred in the Callide Valley this season. Considerable damage was done, but the early-sown plants recovered to a most astonishing degree and set much heavier crops than has ever been the case in this Valley where late-sown plots have been attacked.

*Wet versus Dry Seed Planting Experiment.**—No results of much value were obtained from this experiment of this season owing to the occurrence of 1·02 inches of rain eight days after the date of planting. The rate of germination was slightly in favour of the soaked seed, as the first seedlings appeared twenty-four hours earlier than did those of the dry seed treatment. Under the favourable conditions of soil moisture, however, good " strikes " were obtained in all treatments. The experiment was continued to ascertain if any advantage could be gained by the method of planting in furrows. No outstanding feature was observed throughout the season.

The following table shows the yields obtained:

Treatment.	*Yield per Acre (lbs.).*
Dry drill	1,013 ± 63
Wet drill	1,081 ± 43
Dry furrow	1,029 ± 66
Wet furrow	1,116 ± 65

No significant differences were obtained between any of the yields, so it would appear that under the seasonal conditions all treatments gave comparable results.

Hill Planting Experiment.—The system of planting cotton in hills on the square method has frequently been advocated as a means of reducing the costs of cultivation. Several commercial fields have been inspected in past seasons, and the writer was always struck with two outstanding problems which presented themselves. One was,

How many plants are required in a hill to offset the loss of yield due to the wider spacing? and the other was, What effect will increasing the number of plants per hill have on the growth of the plants? An experiment based on these questions was grown on the Monal Creek Demonstration area in the last season of its operation, 1924-25.* Since then the experiment has been planted on the Research Station, but owing to various disasters no tests have been brought through which would give reliable results. One of the main failures has been the inability to obtain a perfect stand in each treatment, and a certain loss would result where only one plant per hill could be obtained, though this would not be so serious in a commercial field.

The experiment of this past season was planted under excellent conditions, and a nearly perfect strike was obtained. Replanting the few missing hills was early accomplished, so that all plant growth was comparable. The experiences of previous seasons had indicated that under wet conditions and on fertile soils a vigorous growth could be expected where this system is used. Accordingly the rows were left the usual 4½ feet apart, but the distance between the plants was reduced to 3½ feet.

Cross-cultivation was maintained until the middle of December, after which the vegetative branches spread out so badly that further operations with even the walking scuffler between the rows would have severely damaged them.

It is possible that the early rains in October may have greatly assisted in the development of an excessive number of vegetative branches, but this is one of the dangers of such wide spacing of the plants in the row. In a season of showery weather conditions this is a serious drawback, as the stopping of the passage of the cultivators in mid-December necessitates an extra amount of hand labour being expended which will more than offset any savings gained earlier in the season by means of the cross-cultivation.

With the maturing of the top crop of bolls, the plants in the treatments where there were two or three to the hill tended to bend towards the middle of the spaces, thus causing a greater degree of lodging. In some instances this allowed the ends of the vegetative branches to rest on the ground, thereby causing a loss of bolls or a soiling of the seed cotton.

The following table of flower counts from plots of similar size in each treatment shows the effects of the different populations of plants. As would be expected, during the first half of the season the treatment

* See Monal Creek demonstration area section in 1924-25 "Reports on Experimental Work on Cotton."

with the most plants per given space had the most flowers, but as the plants developed, the larger plants in the one-plant-per-hill treatment appreciably increased their rate of flowering over those of the other two treatments.

NUMBER OF FLOWERS IN HILL PLANTING EXPERIMENT.

Treatment.	*Period to Jan. 31.*	*Percentage of Total.*	*Rest of Season to March 31.*	*Total.*	*Percentage with 1 Plant per Hill as 100.*
1 plant per hill ..	786	26·89	2,136	2,922	100
2 plants per hill ..	1,085	35·34	1,985	3,070	105·6
3 plants per hill ..	1,120	36·7	1,931	3,051	104·4

The actual yields obtained, however, show greater differences between the treatments, the data being highly indicative of significant differences between the one-plant-per-hill treatment and both the two- and the three-plants-per-hill treatment.

The following table gives the data of the experiment:

YIELDS OF THE HILL PLANTING EXPERIMENT.

Treatment.	*Yield per Acre (lbs.).*	*Per Cent. Stand.*
1 plant per hill	1,003±32	100
2 plants „ „	1,248±43	100
3 „ „ „	1,336±44	100

Difference between 1 and 2=245±41 lbs.* $\frac{D}{E}$=6·0.

„ „ 2 and 3=88±54 lbs. $\frac{D}{E}$=1·63.

„ „ 1 and 3=333±54 lbs. $\frac{D}{E}$=6·2.

The results obtained from the experiment indicate that anyone using the system of planting in hills for the purpose of cross-cultivation should leave at least two plants per hill. No significant difference was obtained between the yields of the two plants to the hill and the three plants to the hill treatments, although there was a tendency for the larger number of plants to yield at a higher rate per acre. It must be remembered, however, that the plants in this experiment

* The formula used in obtaining the probable error of the difference of two means=$\sqrt{a^2+b^2-2r_{ab}\times a\times b}$. This formula is used throughout the report wherever correlation of results is possible owing to similar soil influences.

experienced a considerable amount of rainfall through most of their growth. In a dry season it may be that the greater competition for moisture where three plants are left per hill might reduce the yield or possibly the quality of the fibre, as compared to the treatment where two plants were left per hill. Comparing the general growth of the plants in the experiment and the yields obtained with adjacent plots of experiments, it could not be seen that any advantage was gained by using the method of cross-cultivation. In fact, owing to the vigorous development of the vegetative branches, the cultivating operations were not as effective as those used in the plots where the plants were spaced at closer distances in the rows.

*Direction of Rows Experiment.**—The general tendency for the growers to use the 24-inch spacing between the plants in their commercial crops made it appear desirable to have only this one spacing in the experiment of this season.

An excellent crop was again produced on this "border," and, but for the late unfavourable climatic conditions, it is believed that last season's record yield for an acre plot on the Research Station would have been equalled. No marked differences could be observed in the development of the plants throughout the season. Counts were made of the number of bolls attacked by boll rot in nine representative sections of rows in each treatment. A total of seventy-four diseased bolls was found on 315 plants in the east and west rows and eighty bolls on 305 plants in the north and south rows. As these are very low populations it is not considered that there was any difference between the treatments on this point.

No significant difference was obtained between the yields of the two treatments. As there was no significant difference between the number of plants per acre it is believed that the results are thoroughly indicative of the merits of the two directions of rows. The following table shows the results and the number of plants on an acre basis:

Direction of Rows.	*No. of lbs. per Acre.*	*No. of Plants per Acre.*
North and south	1,712±21	5,126±63
East and west	1,642±23	4,876±71
Difference	70±31. $\frac{D}{E}$=2·26	250±94. $\frac{D}{E}$=2·66

The results are in keeping with those obtained in the 24-inch spacing section of the experiment of last season. (See Callide Cotton Research Station Report 1926-27.)

The plants in the experiment of both seasons were of good average height and fully tall enough to have tested the point as to which treatment allows more sunlight to penetrate to the lower portions of the plants, and thus reduces the amount of boll-rot attack on the lower bolls. It is believed that no advantage can be gained by either direction, and as advocated in last season's Report, the grower should consider only the economic aspect of the question. Provided the contour and the composition of the land will allow it, a field should be planted so as to obtain the longest rows and thus reduce the amount of turning in the cultivation operations. The experiment is accordingly being omitted from the future investigations of the Station.

*Paired Row Experiment.**—This experiment was first conducted on the Research Station in the season of 1925-26. The Station was newly developed then, and unfortunately a plot possessing unexpected soil irregularities was selected for the experiment. No significant differences were obtained under such conditions, but the experiment was described in the Annual Report of the Station for that season. The experiment was conducted during the next season, but a severe corn ear worm attack from a neighbouring cotton farm affected it so badly that no reliable data could be obtained.

Briefly, the experiment consists of comparing the effects of planting in rows evenly spaced 4½, 5, and 5½ feet apart, with a system of planting in pairs of rows 4¼ feet apart and distances of either 5½ or 6½ feet between the pairs of rows. The idea of the latter method is to attempt to obtain the "outside row" effect which is usually noticeable in most cotton fields. Such outside rows frequently yield higher returns than do the adjacent inside ones, and are usually less affected by "heat waves" or periods of droughty conditions. It has also been observed that in periods of excessively wet weather much less loss occurs in the outside rows from boll rots, shedding of squares, etc. In fact, during this past season, in some crops on rich soils and under conditions of excessive rainfall, only the plants in the outside rows and the first four or five plants at each end of the inside rows bore anything approaching a profitable crop. Attempts to overcome the effects of rank growth by wider spacing of the rows do not always meet with profitable results. Under luxuriant growing conditions the plants in the 5- or 5½-feet spaced rows often develop a very heavy vegetative growth with many large basal limbs which lodge badly, and often the result obtained is not as good as where the normal 4½-feet spacing of rows is maintained.

The experiment of this season, but for some irregularity of spacing, allows a fairly good estimate to be made of the value of the system of planting in pairs. Under the seasonal and soil conditions existing at the Research Station it would appear that no advantage was obtained through using it. This is not surprising when the average growth of the plants over the Station is taken into consideration. The results obtained in the experiment dealing with the investigations of the effects of different spacings between the plants and the rows indicate that the combination of 4-feet spaced rows and 12-inch spacings between the plants within the rows gave decidedly the best yields. This would show that there was not sufficient growth to crowd the plants in the closer spacings, hence the wider spacing was unnecessary, and simply represented a loss in the number of plants per acre.

The results of the experiment are as follows:

Row Spacing.	*Yield in lbs. per Acre.*	*Per Cent. of Perfect Stand.*	*No. of Plants per Acre.*
Rows 4½ feet; pairs 6½ feet ..	1,205±27	102·5	4,059±50
Rows 5½ feet	1,205±24	105·4	4,174±54
Rows 4½ feet; pairs 5½ feet ..	1,366±26	96·6	4,208±65
Rows 5 feet	1,495±32	104·8	4,566±56
Rows 4½ feet	1,340±39	97·3	4,710±57

No significant difference is shown between rows 4½ feet, pairs 6½ feet, and single-spaced 5½-feet rows.

No significant difference is shown between rows 4½ feet, pairs 5½ feet, and single-spaced 4½-feet rows.

Unfortunately an irregularity in the spacing of the section with the 5-feet spacing does not allow this treatment to be compared with the results obtained where the pairs were 5½ feet apart. An examination of the results would lead one to believe that if the stand had been comparable, the pairs spaced 6½ feet apart and the regularly spaced 5½-feet single rows would have given significantly lower yields than either the 4½-feet single-spaced rows or the pairs of 4½-feet rows spaced 6½ feet wide.

The results of the experiment cannot therefore be taken as offering conclusive evidence as to the merits of the treatments under investigation. It is suggested that any growers interested in this problem should experiment in their own fields. A simple comparison can be made by repeating plantings of four pairs of rows at several places in the field. It is believed that where the soils are very fertile and plant growth is apt to be excessive, a spacing of 6½ feet between

the pairs will be the most suitable distance to test with the ordinary 4½-feet spacing of single rows.

Thinning and Spacing Experiment.—This experiment has been under investigation at the Station in previous seasons, but disasters in the form of cutworm attacks, losses from corn ear worm depredations, poor stands, etc., have affected the results so badly that the

TABLES OF YIELDS IN THINNING AND SPACING EXPERIMENT.

Spacing.		*Yield in lbs. Seed Cotton per Acre.*	*No. of Plants per Acre Basis.*		*Per Cent. of Perfect Stand.*
Rows.	*Plants.*		*Correct No.*	*Actual No.*	
4 feet	12 ins.	2,082±66	10,890	10,617±167	98
	24 ins.	1,599±24	5,445	5,590±48	102·5
	32 ins.	1,348±16	3,630	4,100±32	112·5

Difference between 12 and 24 inches=483±69 lbs. $\frac{D}{E}$=7. Very significant.

„ „ 24 and 32 inches=251±42 lbs. $\frac{D}{E}$=6. Very significant.

Spacing.		*Yield in lbs. Seed Cotton per Acre.*	*No. of Plants per Acre Basis.*		*Per Cent. of Perfect Stand.*
Rows.	*Plants.*		*Correct No.*	*Actual No.*	
4½ ft.	12 ins.	1,758±40	9,680	9,332±106	96·5
	24 ins.	1,376±36	4,840	5,076±59	104·5
	32 ins.	1,131±59	3,227	3,678±47	114·0

Difference between 12 and 24 inches=382±47 lbs. $\frac{D}{E}$=8·1. Very significant.

„ „ 12 and 32 inches=245±67 lbs. $\frac{D}{E}$=3·66. Barely significant.

Spacing.		*Yield in lbs. Seed Cotton per Acre.*	*No. of Plants per Acre Basis.*		*Per Cent. of Perfect Stand.*
Rows.	*Plants.*		*Correct No.*	*Actual No.*	
5 ft.	12 ins.	1,881±42	8,712	8,145±118	93·5
	24 ins.	1,224±52	4,356	4,434±44	101·6
	32 ins.	1,100±37	2,904	3,221±34	111·0

Difference between 12 and 24 inches=657±55. $\frac{D}{E}$=11·9. Very significant.

„ „ 24 and 32 inches=111±51. $\frac{D}{E}$=2·18. Not significant.

data have never been considered to be of sufficient value to include in the Annual Report. Some irregularity of stand was present in this past season's experiment, but an inspection of the tables of data presented will indicate that the percentages of correct stand are generally comparable in each plant spacing. The greatest errors occurred in the 3-feet spacings, where the actual spacings averaged around 32 instead of 36 inches.

The yields obtained clearly show the superior value of the closer spacing of the plants in the row in each of the different row spacings. As the odds are all over 19,000 to 1 that the differences in favour of the 12-inch spacing are significant, it can be taken that under the climatic conditions existing at the Research Station this season, this spacing gave the best results.

The data were regrouped in order to study the effect of the spacings between the rows on any particular spacing between the plants.

Regrouping of Data to show Row-spacing Effect on Each Plant Spacing.

12-Inch Spacing between Plants.

Row Spacings.	*Mean Yield per Acre.*	*Per Cent. Stand.*
4 feet	2,082 ± 66	98·0
4½ feet	1,758 ± 40	96·5
5 feet	1,881 ± 42	93·5

Difference between 4 and 4½ feet = 324 ± 77. $\frac{D}{E}$ = 4·2. Significant.

" " 4 and 5 feet = 201 ± 78. $\frac{D}{E}$ = 2·6. Not significant.

" " 4½ and 5 feet = 123 ± 58. $\frac{D}{E}$ = 2·14 " "

24-Inch Spacing between Plants.

Row Spacings.	*Mean Yield per Acre.*	*Per Cent. Stand.*
4 feet	1,599 ± 24	102·5
4½ feet	1,376 ± 36	104·5
5 feet	1,224 ± 52	101·6

Difference between 4 and 4½ feet = 223 ± 43. $\frac{D}{E}$ = 5·2. Significant.

" " 4 and 5 feet = 375 ± 57. $\frac{D}{E}$ = 6·6. "

" " 4½ and 5 feet = 152 ± 63. $\frac{D}{E}$ = 2·42. Not significant.

32-Inch Spacing between Plants.

Row Spacings.	*Mean Yield per Acre.*	*Per Cent. Stand.*
4 feet	1,348 ± 16	112·5
4½ feet	1,131 ± 59	114·0
5 feet	1,100 ± 37	111·0

Difference between 4 and 4½ feet = 217 ± 61. $\frac{D}{E}$ = 3·55. Barely significant.

" " 4 and 5 feet = 248 ± 40. $\frac{D}{E}$ = 6·2. Significant.

" " 4½ and 5 feet = 31 ± 70. $\frac{D}{E}$ = 0·45. Not significant.

From the above tables of regrouped yields it can be seen that there is a fairly significant difference in favour of the 4-feet spacing between the rows in the case of the 32- and 24-inch spacings, but only a barely significant advantage to be gained by spacing the rows 4 feet apart when the plants are spaced 12 inches apart. In all spacings of the plants there is little difference between the yields of the 4½-feet and the 5-feet spacings between the rows. In the 12-inch spacing a slight difference existed in favour of the 5-feet spacing, but of no significant value. In the other two plant spacings the yields were slightly higher in the 4½-feet row spacings than in the 5-feet, but of no consequence.

It would appear, therefore, that the closest spacings of plants and rows in this experiment gave the highest yields. These results are somewhat contradictory to the general experiences of previous seasons. The explanation may be in the peculiar distribution of the rainfall which occurred during this last season. The precipitation graph indicates that the moisture conditions were favourable for forcing a growth early in the season, but barely sufficient to allow the plants to maintain their development during December and January. Much shorter plants than are usually grown on the Research Station resulted from such conditions. The smaller plants would allow of closer spacings between the rows and the plants in the rows. The lack of a really serious shortage of moisture for any appreciable length of time would eliminate any ill-effects from root competition for water so that the closer spacings of the plants simply meant a greater crop-bearing surface per given area of soil.

The following table of flower counts shows the effects of the different spacings:

FLOWER COUNTS FOR THINNING AND SPACING EXPERIMENT.

Treatment.		*On an Acre Basis.*				*Percentage of each Total based on 12-Inch Spacing in 4-Feet Rows as 100.*
Rows.	*Plants.*	*Prior to January 31.*	*Per Cent. of Total.*	*Rest of Season to March 31.*	*Total for Season.*	
4 ft.	12 ins.	165,531	51·2	158,537	324,068	100·0
	24 „	141,897	43·8	181,787	323,683	99·8
	32 „	108,377	33·2	218,584	326,961	101·0
4½ ft.	12 „	178,096	49·2	184,898	362,993	112·0
	24 „	138,666	38·7	219,833	358,499	110·0
	32 „	121,581	36·1	215,528	337,109	104·0
5 ft.	12 „	122,926	41·8	176,069	298,995	92·5
	24 „	127,744	43·8	164,260	292,004	90·2
	32 „	124,625	42·9	165,841	290,466	89·8

A statistical examination by the "Student Method" was made of the percentages of the total number of flowers which had been produced by January 31, to obtain the significance of the differences in the data. The following table gives the results of this method of examination:

Plant Spacing.	*Row Spacing.*								
	4-Feet Spacing.			*4½-Feet Spacing.*			*5-Feet Spacing.*		
	Dif.	*Z.*	*Odds.*	*Dif.*	*Z.*	*Odds.*	*Dif.*	*Z.*	*Odds.*
Difference between percentages of 12 and 24 inches ..	7·27	2·07	332:1	10·52	2·16	399:1	2·17	0·15	1·66:1
Difference between percentages of 12 and 32 inches ..	18·03	4·14	4,999:1	13·16	2·93	1,428:1	1·77	0·11	1·4:1
Difference between percentages of 24 and 32 inches ..	9·97	1·92	243:1	2·65	2·1	369:1	0·4	0·02	—

The results indicate that there were significant differences in the 4- and 4½-feet spacings between the percentages of flowers produced by January 31 in the 12-inch spacings and either the 24- or 32-inch spacings. There were also significant differences between the 24- and the 32-inch spacings. There were no significant differences

between the percentages of open flowers to January 31 in any of the plant spacings in the 5-feet row spacings.

It would appear, therefore, that the following conclusions can be drawn from the experiment:

1. The 12-inch spacing of plants in the 4- and 4½-feet rows was conducive to the early production of flowers, although no definite advantage was gained in the 5-feet spacing.

2. There was but a slight difference between the percentage of flowers set in the 12-inch spacing in the 4-feet rows and in the 4½-feet rows.

3. With the increasing of the widths between the rows the differences between percentages of total flowers set by January 1 in the 12- and 24-inch spacings became smaller.

4. All plant spacings in the 4½- feet row spacing produced a higher total number of flowers for the period under observation.

5. Very significant differences in the yields of seed cotton were obtained in favour of the 12- inch plant spacing in all row spacings.

6. Significant differences in the total yields of seed cotton were obtained in favour of the 24- as compared to the 32-inch plant spacings in the 4- and 4½-feet row spacings, but not in the 5-feet row spacing.

7. The closer spacing of the plants and of the rows therefore forced the early production of flowers which matured in greater numbers by the time of the mid-April storms.

8. Only a small number of bolls opened after this storm and were not of sufficient number in any treatment to give it an advantage.

9. It is possible, therefore, that with more normal climatic conditions during the picking season, a larger amount of the top crop would have been obtained. This might have reduced the differences which were obtained in favour of the closer spacings.

Method of Cultivation Experiment.—The average area of cotton per grower in Queensland tends to increase slightly each season. Several factors have contributed to this, one of the most important being the placing on the market of several suitable types of riding cultivators. Some of these are equipped with tines only, shovels, duckfeet, or similar removable attachments; others can interchange these attachments with carriages fitted with discs for cultivation; while others have only the discs. An experiment was planned during this past season to compare the results obtained by cultivating with tines only, with discs, and also the walking scuffler fitted with tines. Unfortunately the portion of the experiment which was cultivated with the walking scuffler was only partly picked when the heavy storm of mid-April occurred. As it is believed that such a prolonged

wetting might have affected the yields, this part of the experiment is not included.

Little difference could be noted in the growth of the plants on the portions of the experiment where the tines and discs were used. Some cultural advantages were obtained by using the discs, however, as the light mulch worked to the plants checked the growth of any weeds and thus eliminated the necessity of any hand-chipping. One light chipping between the plants to eradicate pigweed was necessary where the tines were used, but it is believed that this can be avoided in ordinary seasons by the use of hillers or shovels on the standards next to the plants.

The following table gives the yields obtained:

TABLE OF YIELDS IN THE "TINES VERSUS DISCS CULTIVATION" EXPERIMENT.

Treatment.	*Yields per Acre Basis (lbs.).*	*No. of Plants per Acre Basis.*
Discs	1,436±72	4,745±97
Tines	1,418±41	4,286±84
Difference	18±78. $\frac{D}{E}$=0·23	459±128. $\frac{D}{E}$=3·55

No significant difference in yield per acre was obtained between the two treatments, although there was a slightly significant difference in the number of plants per acre in favour of the disc cultivated portion. It is believed, therefore, that under the seasonal conditions existing at the Research Station, the use of either the tines or the discs gave comparable results. It is pointed out, however, that in the seedling stages of growth of the plants more efficient cultivation can be given with the tine attachments. If peculiar conditions, such as couch grass, or soil types require the use of discs later in the season, it is believed that the purchase of a machine which will allow of the interchanging of the carriage for tines, duckfeet, etc., with the carriage of discs would be a profitable investment.

*Ridging Cultivation Experiment.**—This experiment is designed to test the merits of the following methods of cultivation: Gradual ridging of the soil to the plants at each operation; flat cultivation for the whole season; flat cultivation for the whole season except at the last operation, when the soil is well ridged around the plants.

No differences could be observed between the growths of the plants in the different treatments. Flower counts on comparable

areas of plants indicated, however, that some differences existed in the rates of flowering during the periods ending at the end of January and for the rest of the season. The following table gives the number of flowers on each plot and the percentages of each for each half of the season:

Table of Flower Counts.

Treatment.	*Number of Flowers.*				*Per Cent. Based on Total of Flat Cultivation all Season.*
	Period ending Jan. 31.	*Per Cent. of Total.*	*Rest of Season.*	*Total to March 31.*	
Ridged all season ..	4,334	42·40	5,886	10,220	102·85
Flat cultivated all season	3,852	38·76	6,084	9,936	100
Flat cultivated all season except for ridging at last cultivation	3,529	34·85	6,597	10,126	101·91

The showery weather conditions during December were very favourable to the growth of pigweed, and this experiment was particularly infested with this weed. The Manager, in commenting on the merits of the different systems of cultivation, advised that all treatments experienced considerable weed growth, but that the rows which were ridged throughout were not nearly so weedy as those which had been flat cultivated.

No significant differences between the yields of the three treatments were obtained, as is shown in the following table:

Table of Yields and Number of Plants per Acre Basis.

Treatment.	*Yield in lbs.*	*No. of Plants.*
A. Flat cultivated all season except ridged at last cultivation	1,374±61	4,616±70
B. Flat cultivated	1,418±30	4,731±125
C. Gradually ridged at each cultivation	1,369±43	4,852±100
Difference between A. and B. ..	44±69. $\frac{D}{E}$=0·64	115±100. $\frac{D}{E}$=1·15
„ „ B. and C. ..	49±36. $\frac{D}{E}$=1·36	121±160. $\frac{D}{E}$=0·76
„ „ A. and C. ..	5±80. $\frac{D}{E}$=0·06	236±122. $\frac{D}{E}$=1·93

The results obtained in a similar experiment in the 1926-27 season gave significant differences in favour of both treatments A and B over C, although soil variation may have affected the results somewhat. In 1925-26, however, slight differences were in favour of treatment C. It would appear, therefore, from the results obtained in the experiment over a period of three seasons, that no significant increase in yield is obtained by gradually ridging all the season. However, in seasons of wet, showery conditions during the month of December, when the pigweed growth is usually heavy, an appreciable reduction in costs of production may be effected by using this method. Under average soil conditions little or no hand labour, other than that used in the thinning operations, will probably be necessary where the soil is gradually ridged to the plants at each operation. In addition to this advantage, a decided brace to the plant is afforded where the soil is ridged to it, which may be of appreciable assistance in preventing the plants from being blown over in severe storms in the early season and also in reducing the amount of lodging when the plants are mature.

*Height of Thinning Experiment.**—This experiment was modified from the one conducted in previous seasons in that only the one distance of 24 inches between the plants was used, as this is becoming the established commercial spacing. The experiment therefore consisted of testing the effect of thinning the plants when they were 6 to 8, 10 to 12, and 14 to 16 inches in height, to a distance of 24 inches apart in rows spaced 4 feet 6 inches.

Under the unusual rainfall conditions in October a vigorous development of the plants occurred, and the effect of the early thinning was to allow the formation of a greater number of large vegetative branches than usually develop in the early-thinned plants. The plants thinned when 10 to 12 inches high also carried a fair number of vegetative branches, but the dry spell in November, in conjunction with the delayed thinning, had a tendency to toughen up the plants and thus restrict the growth of the vegetative branches. The plants which were thinned when 14 to 16 inches high clearly showed the effect of the combination of delayed thinning and dry weather. Many plants were of the " single stalk " habit of growth and of a spindly nature when thinned. The rains at the end of November occurred a few days after the last thinning, the effect of which was to force a steady growth of main stalk and fruiting branches in the 14-to 16-inch treatment.

The vegetative development of the earlier thinned plants continued under such conditions. Considerable shedding of squares

occurred in these thinnings during January and February, whereas only a light loss of squares occurred in the 14-to 16-inch thinning. This may explain the results of the flower counts, which indicate that a greater number of flowers were set in the 14- to 16-inch thinning. The following table sets out the data on this point:

FLOWER COUNTS OF HEIGHT OF THINNING EXPERIMENT.

Treatment—Height of Thinning.	*Number of Flowers.*				*Percentage Based on 6 to 8 in. Thinning as 100.*
	Period to Jan. 31.	*Percentage of Total.*	*Rest of Season to March 31*	*Total.*	
6 to 8 ins. ..	8,963	49·5	9,145	18,110	100
10 to 12 ins. ..	8,068	43·2	10,596	18,664	103
14 to 16 ins. ..	8,534	44·0	10,844	19,378	107

It would appear that the 6- to 8-inch thinning allowed of the formation of the lower fruiting branches as well as the vegetative branches. This gave greater square-bearing surface early in the season, with the result that the plants of this treatment produced more flowers for the period ending January 31. From then on, however, the later-thinned plants flowered more heavily, especially towards the end of the season.

Unfortunately a variation in the stand existed in the latest-thinned plants so that the results are not strictly comparable. The following table gives the data of the experiment:

HEIGHT OF THINNING EXPERIMENT.

Treatment.	*Yield in lbs. per Acre.*	*No. of Plants per Acre.*		*Per Cent. Stand.*
		Correct.	*Actual.*	
A. 6 to 8 ins. ..	1,542 ± 34	4,840	4,726 ± 54	98
B. 10 to 12 ins. ..	1,431 ± 39	4,840	4,619 ± 33	95·6
C. 14 to 16 ins. ..	1,424 ± 35	4,840	4,415 ± 36	91·3

Difference A. and B. = 111 ± 51 lbs. $\frac{D}{E}$ = 2·18 – 107 ± 61 plants. $\frac{D}{E}$ = 1·75.

„ B. and C. = 7 ± 46 lbs. $\frac{D}{E}$ = 0·15 – 204 ± 47 „ $\frac{D}{E}$ = 4·34.

„ A. and C. = 118 ± 47 lbs. $\frac{D}{E}$ = 2·5 – 311 ± 63 „ $\frac{D}{E}$ = 4·95.

No significant differences were obtained in the yields picked from the experiments. However, the stand in the 14- to 16-inch treatment was only 91·3 per cent. perfect, and, as the statistical treatment of the data indicates, the odds were at least 333 to 1 that there was a significant difference in the plant populations of the earlier and the late-thinned treatments, the results cannot be taken as being an accurate indication of the yielding properties of the 14- to 16-inch treatment.

Material was collected from thirty plants* in each treatment, to allow of the study of the effect of each on the average number of the four- and five-locked bolls per plant and their average weights; the average number of seeds per lock of each four- and five-lock boll; and the average number of bolls required to yield a pound of seed cotton. Significant differences were obtained in only the following classes and comparisons.

Treatment.	*Average Number of 4-Locked Bolls per Plant.*			*Average Weight in Grammes, 4-Locked Bolls.*			*Average Number of Bolls per lb. Seed Cotton.*		
	No.	*P.E.*	*S.D.*	*Weight*	*P.E.*	*S.D.*	*No.*	*P.E.*	*S.D.*
A. 6 to 8 ins. ..	21·16	±0·94	7·6	5·29	±0·06	0·51	83·8	±1·09	8·83
B. 10 to 12 ins.	22·6	±1·05	8·6	4·84	±0·01	0·1	90	±1·12	9·11
C. 14 to 16 ins.	26·66	±0·83	6·7	5·27	±0·04	0·36	84·4	±0·89	6·85
Difference A.–B	5·44±1·41. $\frac{D}{E}$=3·85			0·45±0·06. $\frac{D}{E}$= 7·5			6·2±1·56. $\frac{D}{E}$=3·97		
Difference A.–C.	5·5 ±1·25. $\frac{D}{E}$=4·4			—			—		
Difference B.–C.	—			0·43±0·04. $\frac{D}{E}$=10·7			5·6±1·26. $\frac{D}{E}$=4·45		

The explanation of the low weight of the four-locked bolls in the 10- to 12-inch treatm ent is not clear. The standard deviation indicates a low variation in weight for the bolls weighed, so that it is not believed that soil differences played an important part. The low weight of the four-locked bolls would account for the greater number of bolls per lb. of seed cotton required in this treatment.

The results of this experiment in 1926-27 and 1925-26, while not clearly conclusive, gave indications that heavier yields would be obtained in the earlier thinnings.

* Three lots of ten consecutive properly spaced plants were taken from comparable locations in each treatment.

Luxuriant growing conditions did not exist during the early period of the development of the plants in these seasons. It would appear, therefore, that, in a season of plentiful rainfall, no material damage is caused by early thinning, and possibly some gain may be effected, while in a season of only moderate rainfall, the early-thinned plants increase the chance of obtaining good yields. Another advantage gained by early thinning is the increase in the rate of performing the operation. Plants 4 to 6 or 8 inches high can easily be chopped out by means of light goose-necked garden hoes, whereas the taller plants have either to be pulled by hand or chopped out with a heavy eye hoe at a greatly reduced rate per day. It is therefore believed that early thinning is advisable for most growers.

Insect Problems.

This season was marked by a very heavy occurrence of thrips during the seedling stages of the cotton plants and by a serious invasion of the corn ear worm from a neighbouring commercial crop of cotton. Other cotton insect pests were present, but not in sufficient numbers to do damage of economic value.

Thrips (*Thrips Tabaci* Lindeman).—This very minute insect occurred in large numbers during the dry period prior to the October rains. Investigations* into its habits gave very clear evidence of the effects that an attack by it would have on the cotton seedlings. It is believed that this insect has been causing some of the loss of terminals which has occurred each season on the Research Station whenever dry conditions existed for any length of time after planting. During this past season all early planted cotton was affected to an appreciable extent by the loss of terminal buds. This caused a stoppage of the growth of the main stalk and thus forced the development of a large number of vegetative branches per plant. The same condition existed to an even worse degree last season, when many plants had eight to twelve vegetative branches occurring in such a manner as to form a strong resemblance to the stool of branches of a cereal plant.† The same freedom from loss of terminals did not exist in the late plantings of last season as it did in 1927-28. It is believed that October storms occurred sufficiently early to clear up the thrips in time for the November and December plantings to escape any damage from them. In the previous season the dry conditions continued into December, so that it would have been possible for the

* These investigations were conducted by Mr. G. A. Currie, B.Sc., Assistant Entomologist of the Queensland Department of Agriculture and Stock.

† See "Callide Cotton Research Station Annual Report, 1926-27," p. 13.

thrips to be present in sufficient numbers to have caused the large loss of terminals in these plantings.

Cut Worms (*Euxoa Radians* Guen).—An absence of cut-worm attack characterized the early season conditions at the Research Station and in nearly all cotton-growing districts of the State during the past season. Investigations* in this country tend to demonstrate that such an absence of this species of cut worm is more or less correlated with conditions of abundant rainfall during certain critical periods. The results of experiments and field demonstrations of the previous season clearly indicate the value of poisoned bran mashes for eradicating this pest when it occurs. It is believed, therefore, that in seasons of dry conditions during the months of October and early November, the cotton-grower will be well advised to have a supply of Paris green and bran† on hand for possible occurrences of cut worms.

Corn Ear Worm (*Heliothis Obsoleta* Fab.).—A very serious outbreak of the corn ear worm was experienced in several sections of the Callide Valley during this past spring. Many growers in an effort to increase their cotton acreage left portions of their cotton fields of last season and concentrated their activities on getting as much new land ploughed and ready for planting as they could. Excessive weed growth developed in the old cotton fields owing to the early occurrence of storms in September, and by the time the new land was planted, the cleaning up of the "standover" crops presented a serious problem. Some fields were cleaned up, but the majority of them, which were intended for ratooning, were left until planted crops were thinned and cultivated, when they were ploughed out. A very heavy emergence of moths apparently occurred in September, for some of the standover plots were alive with the grubs towards the end of the month. In one case, 2 acres of adjacent plant cotton were destroyed in a few days by a migration of corn ear worm. Fortunately a large number of birds attacked this migration and destroyed it. The grubs mostly remained in the standover fields, and in December each such plot was a serious source of infestation. A farm adjacent to the Research Station suffered a very severe attack on a 60-acre field of cotton which was adjoining a small standover plot. The caterpillars not only destroyed bolls and squares, but even cut off the tips of the main stalks and vegetative branches. This attack spread on to the

* A Bulletin by Mr. G. Currie, B.Sc., Assistant Entomologist, containing a study of this species of cut worm in Queensland, is shortly to be published by the Department of Agriculture and Stock.

† See Part II., "Cotton Growing in Queensland," Department of Agriculture and Stock.

east side of blocks H., I., J., and K. of the Research Station and caused serious loss of crop.

A lucerne plot on the Station proved very attractive to the corn ear worm moths, and a very large population of grubs developed in it. These migrated to the neighbouring cotton plots in E. block, which were separated from the lucerne by an 18-feet roadway. The attack was destroyed, however, by ploughing an intervening furrow and distributing poisoned bait and by dusting the infected portions of the cotton plots with calcium arsenate at the rate of 25 lbs. per acre. As many as fifty dead grubs were found under a cotton plant at the end of the row nearest the lucerne plot. The occurrence of such an outbreak raises the question of the advisability of having a lucerne field adjacent to the cotton fields. Further study will be required before any suggestions can be made on this point.

The outstanding feature of the corn ear worm situation on the Station was the markedly smaller population which occurred in the February and March broods. With such a heavy early infestation it was feared that serious losses would be experienced when the later broods arrived, but apparently the parasites developed in sufficient numbers to control them. Very heavy parasitization occurred, as could be seen by the large numbers of infected grubs, which suffered from both egg-laying and predatory enemies.* Very little damage was experienced in any of the fields of plant cotton which were isolated from the standover fields, but several fields adjacent to them suffered very heavy losses. The outbreak clearly demonstrates the value of clean cultivations adjoining the cotton fields, and as there is no necessity for anyone in the Callide Valley to attempt to ratoon to obtain a stand, it is to be hoped that no further attempts to do so will be made. In fact, the majority of the old fields failed to give more than a 50 per cent. stand, so that the system has no merits, in this section, on this point.

Pink Boll Worm.—Examinations of locations similar to those where counts were made last season indicated that the methods that were being used on the Station to control the pink bollworm were effective. In May, 1927, all the bolls on forty-two representative plants of early-sown cotton were examined in a 0·7-acre plot which was in the locality where the original infestation of pink bollworm occurred on the Station. An infestation of 1·5 per cent. was found in the material collected. In March, 1928, in the same plot location, all

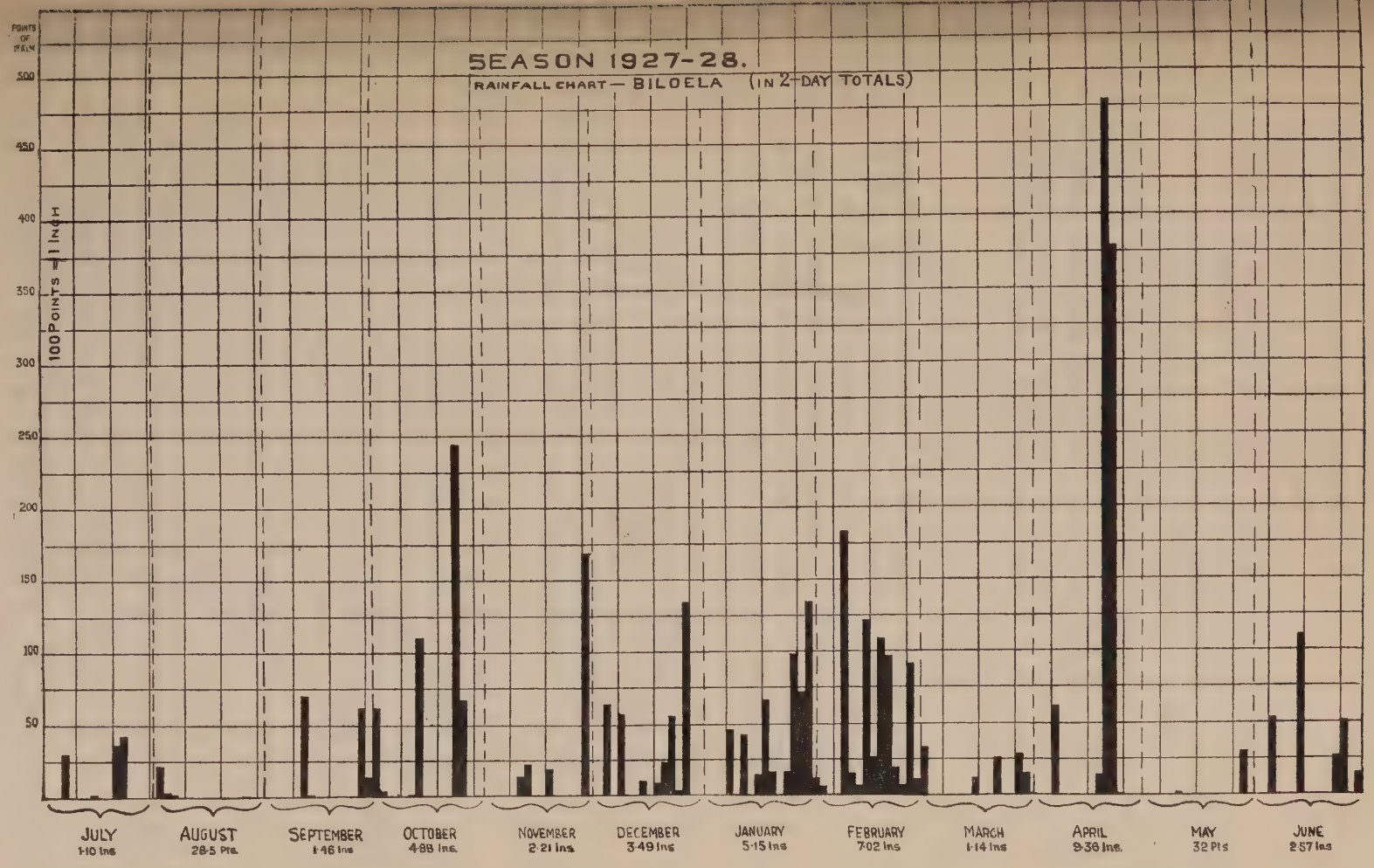
* See Part II., Bulletin: "Cotton Cultivation in Queensland," Department of Agriculture and Stock, in which the parasites of the corn ear worm in Queensland are given.

of the bolls on six lots of five plants each, scattered in a representative manner, were examined, and of 977 bolls, 1·125 per cent. were found infected. In July in the same plot, on a similar number of plants, all unopened bolls which were three-quarters grown or better, were examined, and of 380 bolls, 4·2 per cent. were found infected. As all of the plants on the Station are cut by means of the slide-cutter and raked up and burned, it is believed that a clean-up is made each season which will keep the population of pink boll worms down to a point where any damage done will be of little commercial significance.

Sucking Bugs.—The Harlequin Bug (*Tectacoris lineola* F.) appeared on the Station during this past season, but in lesser numbers than in the last season. An experiment was planned to study the merits of hand-picking of the insect and egg clusters, but owing to the small numbers present it was not considered worth while to conduct the experiment.

The large and small Stainers (*Dysdercus Sidæ* Montr. and *Oxycarenus luctuosus* Montr.) were also present, but not in serious numbers.

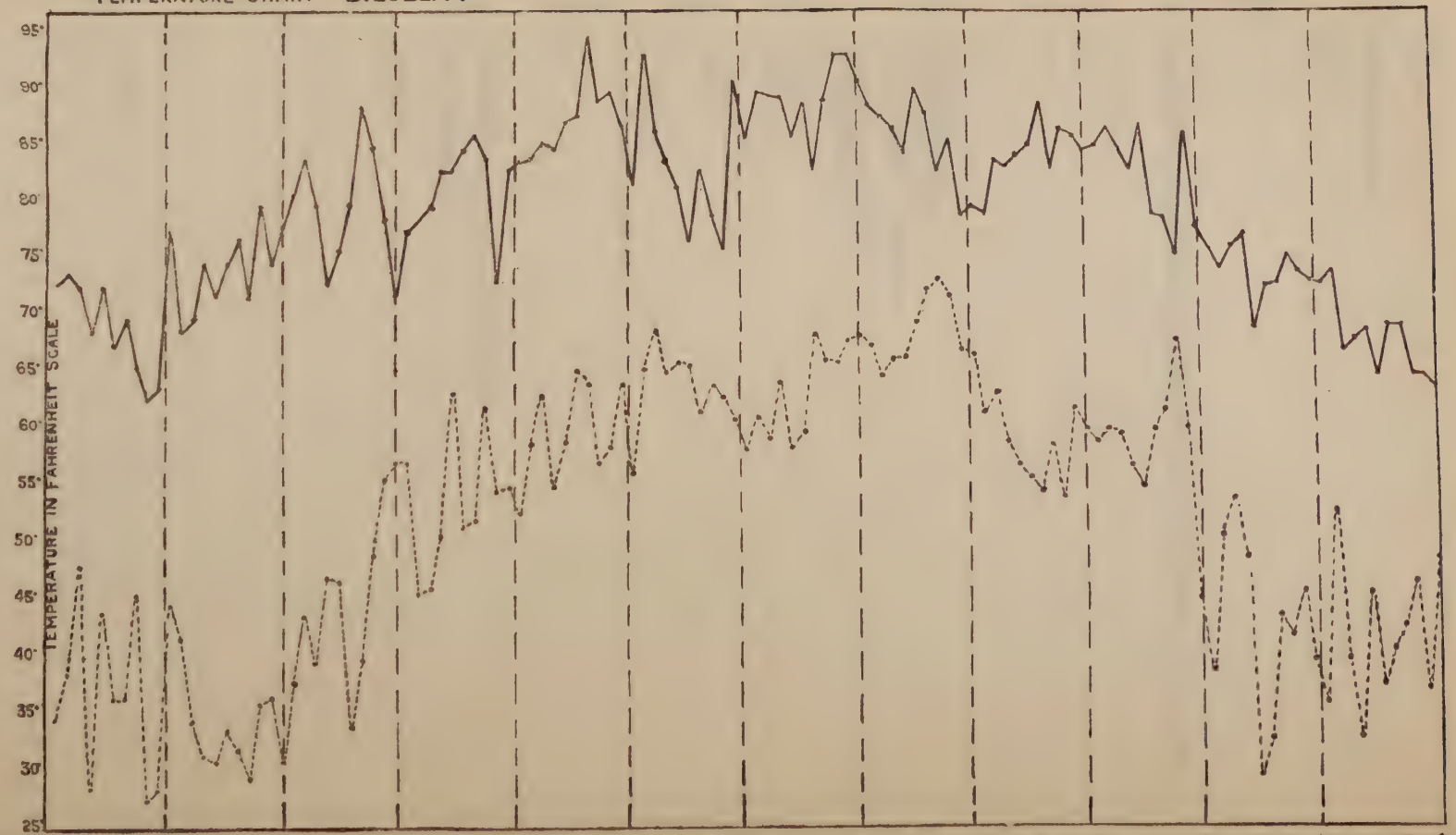
The " False Stainer " (*Aulacosternum nigrorubrum* Dall.) was also present, but not in numbers of economic importance.


SEASON 1927-28.
RAINFALL CHART — BILOELA (IN 2-DAY TOTALS)
POINTS OF RAIN
100 POINTS = 1 INCH
500
450
400
350
300
250
200
150
100
50
JULY 1·10 Ins
AUGUST 28·5 Pts.
SEPTEMBER 1·46 Ins
OCTOBER 4·88 Ins.
NOVEMBER 2·21 Ins.
DECEMBER 3·49 Ins
JANUARY 5·15 Ins
FEBRUARY 7·02 Ins
MARCH 1·14 Ins
APRIL 9·36 Ins.
MAY 32 Pts
JUNE 2·57 Ins

SEASON 1927-28.

TEMPERATURE CHART BILOELA.

THREE-DAY MEANS { MAXIMUM —•—•—
MINIMUM ----•----•----



SOUTH AFRICA

REPORT OF THE CORPORATION'S WORK AT THE STATIONS AT BARBERTON, TRANSVAAL, CANDOVER ESTATES, NATAL, AND IN SWAZILAND, FOR THE SEASON 1927-28

INTRODUCTORY NOTE BY MR. S. MILLIGAN.

As explained in previous reports, the ultimate success of cotton farming in the Union is likely to depend largely on the extent to which the crop can be protected from insect attack, and on the development of suitable alternative crops. The Cotton Stations established by the Corporation on the low veldt in collaboration with the Administration have been mainly engaged in work along these lines. Although themselves still in the development stage and consequently unfitted for any investigation work of a refined nature, important problems requiring immediate attention have been forced upon them. In spite of a series of unfavourable seasons, considerable success along one line at least has been attained. The most pressing problem has, so far, been to deal with jassid attack, which a few years ago was recognized as serious only in years of excessive rainfall. It has now become an annual occurrence, reducing the yield to such an extent as to render cotton-growing quite unprofitable. A piece of good luck in the shape of a really bad jassid year in 1924-25, when the work at Barberton was started, made the selection of jassid-resisting plants possible: the urgency of the case demanded rapid multiplication of the strains breeding true to the jassid-resisting character, and the result is seed sufficient for about 25,000 acres for the season 1928-29, only just in time to prevent a wholesale abandonment of the crop in some of the best low veldt areas.

As will be readily understood, the whole resources of the Stations have been thrown into this work, involving selection, testing, and multiplication, and it has not been possible to devote anything like the attention which other questions, such as bollworm attack and alternative crops, undoubtedly deserve. The elimination of jassid as a major problem will, however, provide a much-needed relief, and permit of a more concentrated effort in other and, ultimately, no less

important directions. The detailed examination of jassid-resisting st ains out of single plant selections, necessitated by the jassid problem, has, however, been productive in other directions—particularly in bringing into prominence a strain of great promise—viz., U.4. A single plant three years ago, this strain was for the first time tested under field conditions during last season. From Candover in Zululand to Mazabuka in Northern Rhodesia, it was outstanding amongst all other varieties grown alongside. Yield tests in the Union showed an average increase of 50 per cent. above our next best jassid-resister, and 100 per cent. over the old Union non-resistant varieties of Improved Bancroft, Zululand Hybrid, and Uganda (its parent variety). No doubt the difficult season contributed to this remarkable performance, but ability to stand up to adverse conditions is above all what is wanted in South Africa.

For re-selection work U.4 bulk appears to be admirably suited, as it is by no means uniform in habit and the component types on the whole possess agricultural characters of great value. It also belongs to the small-bolled prolific type, which is likely to be less affected by bollworm—red bollworm at any rate—than the larger-bolled and slower-flowering types, and it is hoped it may figure as an antidote to this pest.

In connection with bollworm, mention is made in the Candover report of an egg parasite found originally in an abandoned cotton field. Several red bollworm parasites have already been noticed by the Government Station at Rustenburg, and a parasite of the American bollworm has quite recently been discovered by Mr. Taylor, Government Entomologist, at Barberton. The situation with regard to natural control of the pest appears, therefore, to be more hopeful than it has yet been. It is perhaps too early to express any definite opinion on the value of trap crops for the red bollworm, mentioned in the reports, but the results of the study of the moth emergencies at Candover would appear to indicate the necessity for measures in the early part of the season. Stand-over cotton from the previous crop is undoubtedly an excellent trap for the earlier emerging moths, and has been proved to be practicable from the farmers' standpoint, but it still remains to be proved that it will be sufficiently effective to make any great difference in the middle and at the end of the season.

Light traps have given some indications of success at Candover, and the question will be gone into more thoroughly this year.

The provision of alternative crops is now one of the most pressing problems connected with cotton-growing on the low veldt. Much of

the land has been developed on a purely cotton basis, and little has been done with other crops. It is obvious that no farming industry can exist under such conditions without undergoing great risks. Not only is it desirable to have alternative crops from the point of view of the principles involved in crop rotation, but it is now clear that even in the low veldt with its prolonged growing season there are definite limits (due largely to the accumulation of insects at the end of the season) to the time for planting cotton. Quick-growing, early-maturing crops other than cotton are thus required for the late seasons. The question has received considerable attention at all three Stations, and a wide range of possible crops has been grown during the past three years. As was to be expected, most of these have exhibited individual disabilities, owing to disease, insect attacks, and general local unsuitability. A few, however, show promise, but have yet to be tested on a field scale. The question is recognized as urgent, and will receive renewed attention.

REPORT ON THE WORK OF THE COTTON BREEDING STATION, BARBERTON, TRANSVAAL, FOR THE SEASON 1927-1928

BY

F. R. PARNELL.

Introduction.

Station.—In last year's report it was mentioned that proposals had been made for an expansion of the work and a general improvement in the facilities of the Station. These proposals were accepted by the Corporation and are now being put into effect. The expansion and development of the Station were not started till well on in the season and, apart from occupying a certain amount of time, have made no difference to the season's work. Further reference to this subject, therefore, will be deferred to a special section at the end of this report.

An important increase in the Staff, however, was made immediately by the appointment of Messrs. O. V. S. Heath and L. H. A. Stone, who joined for duty in September, just before the beginning of the season.

Season.—The rainfall for the year, July to June inclusive, was 25·89 inches, as compared with an average of 29·71 for the previous twelve years. This total was reasonably good, but the distribution was decidedly poor, as will be seen from the accompanying rainfall table and chart (pp. 53 and 54). Much of the rain fell in short heavy showers, resulting in loss by run-off and rather widespread damage from wash.

From the point of view of the general crop in the district the season started well enough, though the dry period in November hampered planting to some extent. A very wet period with 11·95 inches in thirty-eight days, from the end of December to early February, produced a sappy growth in the plant, and this was then followed by a very dry spell giving only 2·1 inches in fifty-nine days. This dry spell was too much for the soft plant, and resulted in excessive shedding which, coupled with a bad attack of jassid on the debilitated plant, ruined all hope of good crops.

On the Station a very good start was made, and all important material was planted by the end of the first week in November.

Stands were generally rather poor, as the seed from the previous dry season was badly developed, but the plants were growing well. On November 26 there was a violent storm and a heavy fall of hail on the Station. The whole of the growing crop was very seriously damaged and never recovered. It was realized that all variety trials were ruined, and these were replanted as early as possible on fresh land. Through lack of experience of such damage, it was thought that the selections would recover sufficiently to give a ragged stand of good plants; surplus seed, therefore, was used for gap-filling. This was a mistake, as the original plants continued to die off gradually till practically all were gone. The replants did very badly, since the conditions were poor, the land having been consolidated very much by the hail, and it would have been far better to have made an entirely new planting on freshly prepared land.

Another factor that helped to damage the crop was aphis. This was very prevalent at times, especially in early March, when the plants were suffering from drought. The general unhealthiness of the crop undoubtedly encouraged aphis, and the combined effect was very severe in places. This was noticeable on the general crop in the district as well as on the Station.

SELECTIONS.

The work on selections was continued on the same lines as in previous years, and was intended to form the main work of the season. About 400 progeny rows were planted, comprising re-selections from strains in their third or fourth years, together with a large number of the most promising bulks. The progeny rows were all put in before the hail, and were badly cut about. The replants came to little or nothing, and the material as a whole was useless for making comparisons or forming any reliable judgment. Seed has been taken from 115 progeny rows, one or more in all the important strains, occasionally from single plants, but more often as small bulks. Next year's material from this seed will be rather unsatisfactory to work with, but it is the best that could be done in the circumstances. All the bulks planted gave a certain amount of seed, and this will provide material for further selection if required.

U.4—New Selections.—The multiplication plots of U.4, the best strain of the previous season, were most encouraging. The very free-fruiting nature of the strain and its ability to make the best of both good and bad conditions were constantly noticeable. The plots were all planted with original bulk seed, however, and there was a good deal of variation inside the general type. The original re-

selections from this strain, made in the 1925-26 season, amounted to six plants only; moreover, the material derived from these was badly hit by the hail. It was decided, therefore, to make an entirely new lot of re-selections from the original bulk on the multiplication plots.

A thorough examination was made of five plots, 14 acres of crop, covering a wide range of conditions on farms in the district. The spacing on these plots was wider than ordinary, and the material was very suitable for selection work, since the plants were well developed individually. Two hundred plants were selected, covering as wide a range of types as appeared to belong to the strain, and showed thoroughly satisfactory economic characters. Most of the selections were good plants of moderate size and of commonly occurring types of habit and general characters: it is hoped, therefore, that they will not give rise to an undue proportion of splitting lots. The whole group forms an extremely attractive lot of plants possessing very great possibilities. The photographs, Plates I. and II. (p. 55), show two nice types of selected plants, well and evenly covered with bolls. The former had been picked and the empty shells only remained; in the latter the cotton was put back into the bolls, after picking was finished, to show up the plant.

A noticeable feature of the selections is the frequent combination in one plant of many of the most desirable economic characters. Of the 200 field selections some of the least desirable were thrown out after laboratory analysis. A general idea of the characters of the group may be obtained from the average figures, given below, for the 178 plants retained.

RE-SELECTIONS FROM U.4.

	Yield of Seed Cotton (Grms.).	*Ginning Percentage.*	*Boll Weight (Grms.).*	*Weight of 100 Seeds (Grms.).*	*Lint Length (Mms.).*
Average of 178 plants ..	279	35·6	5·1	9·6	30·6

Several plants gave over 600 grms. of seed-cotton, and the biggest yield was 728 grms., well over half a pound of lint. There were many plants of this size on a plot that had been irrigated, but only three or four were included in the selections, the high average figure for yield being due to the excellent fruiting of the general run of moderate-sized plants.

VARIETY TRIALS.

At the end of the previous season there were three very promising strains—Z.1, U.4, and A.12—of which fairly large quantities of seed were available. In view of the urgent need of seed for general distribution, it was decided that all three should be multiplied as much as possible in the season under review. At the same time further information as to their comparative value was obtained from definite experiments, supplemented by general observations on the multiplication plots. Two variety trials were put in for this purpose—one on the deep red loam of the Station, and the other on a shallow granite soil on a neighbouring farm. In each case the half-strip method was employed, and local Improved Bancroft was used as the standard. Six repetitions were made, to give twelve comparisons, of plots 80 feet long by four rows wide, two rows to a half-strip.

In addition to the above more advanced strains, there were several others coming on that required to be tested. A separate group of the seven best lots, including the above three, were put into another experiment on the Station, of the same design, but with Z.1 as standard.

Both experiments on the Station were badly damaged by the hail, and had to be replanted later on fresh land. The experiment on granite soil was planted about the same time, December 1, since the dry weather in the middle of November had held up earlier planting. Growth was poor in all three cases, though the crop on the granite was more healthy than the others. In all three experiments the stand of many of the plots was seriously affected by wash or by the depredations of white ants and millipedes. The plots as they stood, therefore, could not be used for yields as originally intended.

Information on the behaviour of the strains was urgently required as a guide in future multiplication and distribution, and it was necessary to make the most of anything that could be got from the experiments. Regular records of *growth*, *flowering*, *bolling*, and *jassid infestation* were kept, using groups of average plants scattered over the plots, and varying in number for different records. The results obtained from the different experiments were very similar and may, therefore, be accepted as reliable for the conditions of the experiments. In the seven-variety trial the only strains that did well were the same three as were tested against the local variety in the four-variety trials. The results that follow are confined to these three strains, together with the local variety, Improved Bancroft, where that was included.

Growth.—Weekly measurements were made of ten plants per plot on four or five plots for each strain. The measurements were from

ground level (the head of a 6-inch nail driven flush) to the base of the apical bud. Figs. 1 and 2 (p. 39) show the weekly increments obtained on the two four-variety trials. The strains behaved in the same manner in both trials, as also in the seven-variety trial, which is not shown. It will be seen that U.4 got away well in advance, and made more rapid growth than the others in the best growing period, the first three weeks in February. Z.1 showed good early growth, and kept it up better than the others in the dry spell, last week of February and early March, which checked everything so severely. It should be noted in this connection, however, that Z.1 was decidedly late in flowering as compared with U.4, and this fact would tend to encourage the later growth. A.12 and Bancroft both showed a much smaller growth of a very similar nature.

Flowering.—Daily flower-counts were made on fifty plants per plot, for four or five plots of each strain, in the four-variety and seven-variety trials on the Station. The results are shown in Figs. 3 and 5 (pp. 40-41), where the curves have been smoothed by taking means for two-day periods and overlapping three such means. In each case U.4 started well ahead of the others and maintained a big lead throughout the greater part of the main flowering season. A.12 was later and lower, and Z.1 was about the same period as A.12, but lower and not finishing out so well. The Bancroft was very low, and fell off much earlier than the others. These results bear out general observations to the effect that U.4 is capable of producing a big flush of flowers very rapidly, thus being in a position to take every advantage of any spell of good conditions.

Bolling.—Weekly pickings were taken from the same groups of plants as were used for flower-counts. The numbers of bolls picked were recorded, and good bolls were taken separately to give the boll-weights for the plot and week. The results are given in Figs. 4 and 6, where the yields shown are theoretical yields, *number of bolls picked* × *boll-weight*, and not the actual weights taken. This course was adopted in order to avoid any differential effect of boll-worm-damaged bolls on the comparatively small number of plants dealt with. As would be expected from the flowering curves, U.4 is well ahead of the others, especially in the earlier pickings. It is also ahead of A.12 later, at a point corresponding with a flowering time at which A.12 was producing as many or more flowers. This is more particularly marked in the seven-variety trial (Figs. 5 and 6), and indicates a lower rate of shedding for U.4, a point that will be mentioned later. A.12 did better in the four-variety trial, where it was not very far behind U.4 and decidedly above Z.1, than

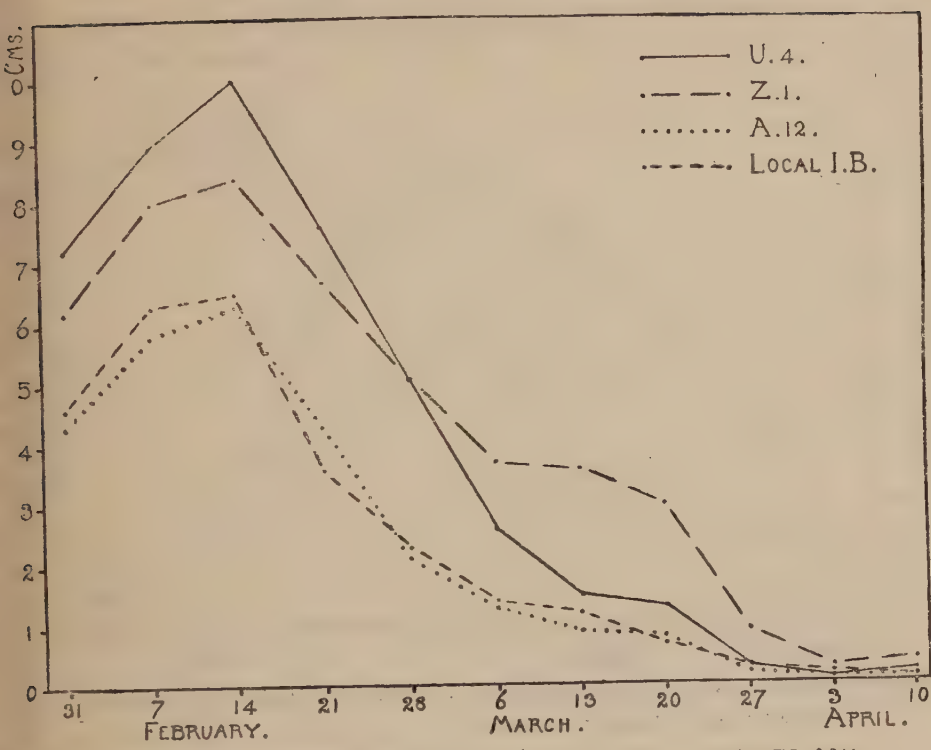


FIG. 1. WEEKLY GROWTH INCREMENTS 4-VAR. EXPT., GRANITE SOIL.
MEANS OF 40 PLANTS.

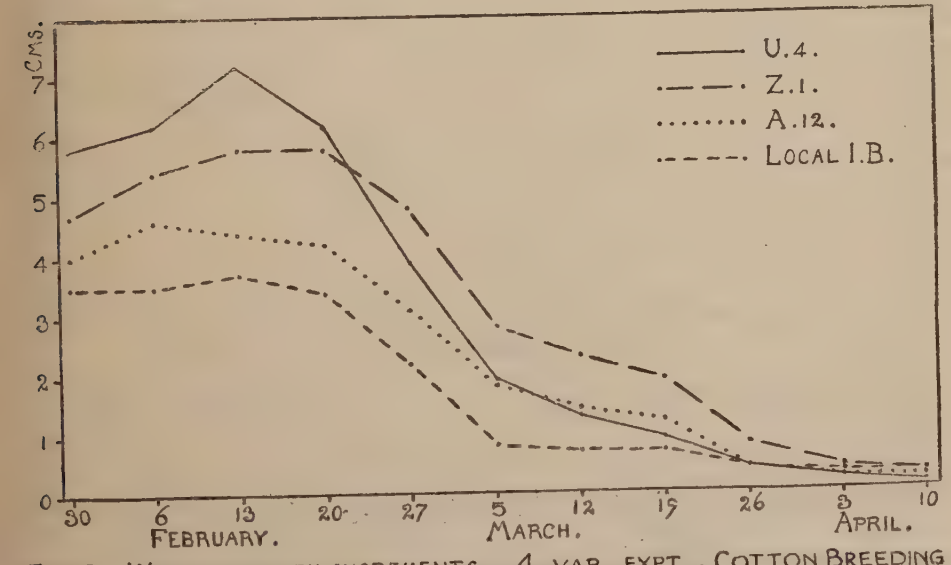


FIG. 2. WEEKLY GROWTH INCREMENTS. 4-VAR. EXPT., COTTON BREEDING STATION.
MEANS OF 50 PLANTS.

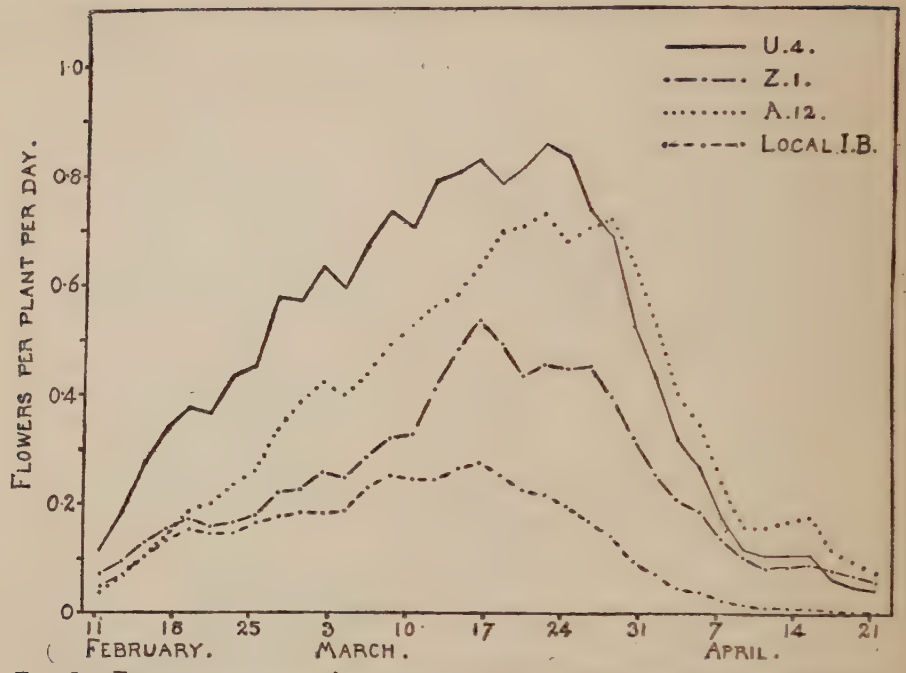


FIG. 3. FLOWER COUNTS. 4-VAR. EXPT., COTTON BREEDING STATION. 250 plants. OVERLAPPING 3 TWO-DAY MEANS.

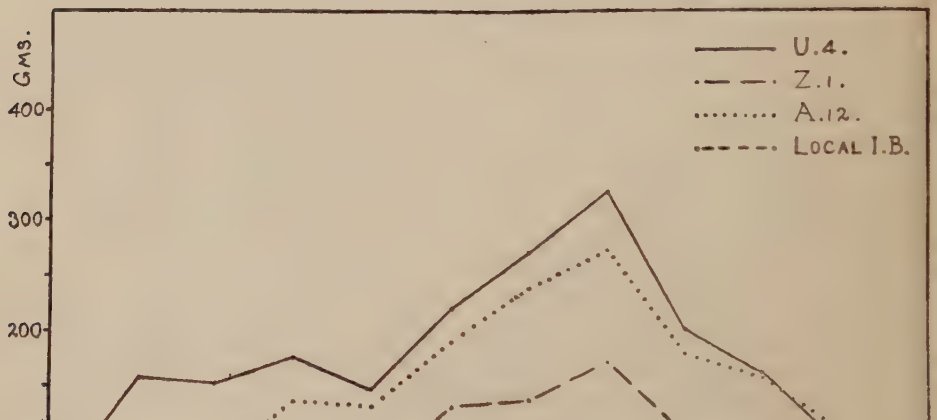


FIG. 4. WEEKLY PICKINGS, TOTAL BOLLS × BOLL-WEIGHT. 4-VAR. EXPT., COTTON BREEDING STATION. MEANS OF 5 PLOTS, 50 PLANTS EACH.

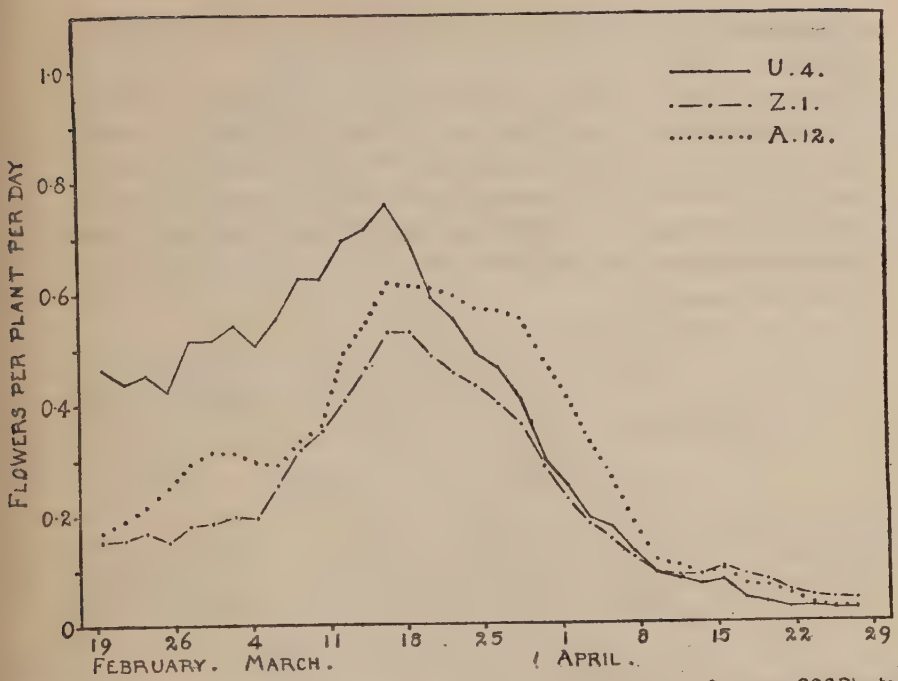


FIG. 5. FLOWER COUNTS. 7-VAR. EXPT., COTTON BREEDING STATION. 200 PLANTS., OVERLAPPING 5 TWO-DAY MEANS.

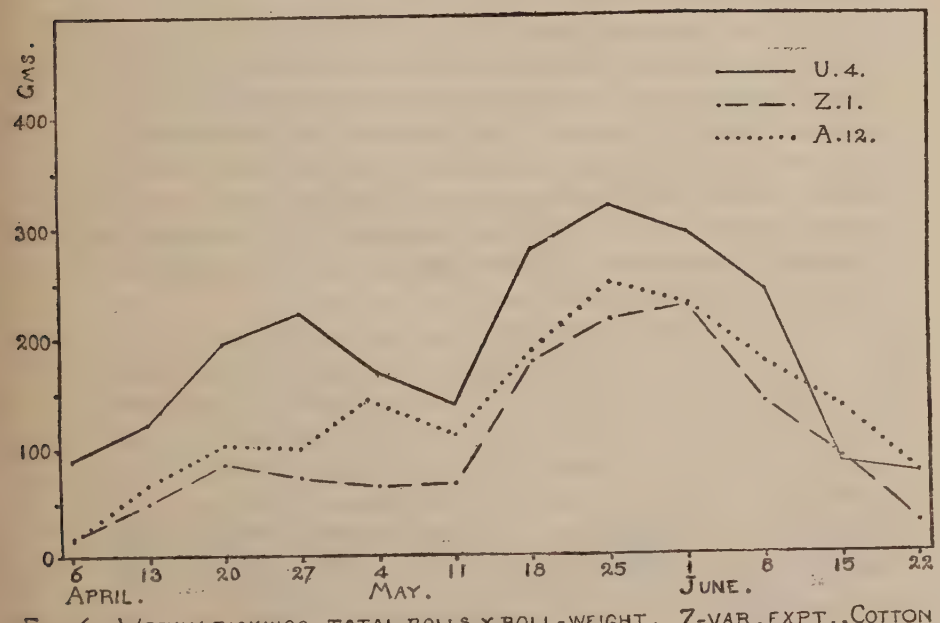


FIG. 6. WEEKLY PICKINGS, TOTAL BOLLS × BOLL-WEIGHT. 7-VAR. EXPT., COTTON BREEDING STATION. MEANS OF 4 PLOTS, 50 PLANTS EACH.

in the other trial, where it was well below U.4 and little better than Z.1.

The total results of the flowering and bolling records on the above two trials are given in the table that follows. The marked superiority of U.4 over A.12 and of A.12 over Z.1 is evident, as is also the very great inferiority of the local Bancroft. The figures also show that U.4 is well up on the others as regards the percentage of bolls matured to flowers opened, this in addition to producing a greater number of flowers.

Per Plot of Fifty Plants.	*Four-Variety Trial (Five Repetitions).*				*Seven-Variety Trial (Four Repetitions).*		
	U.4.	*A.12*	*Z.1.*	*Bancroft.*	*U.4.*	*A.12.*	*Z.1.*
Total flowers	1,659	1,344	892	476	1,294	1,067	822
Total bolls	443	310	192	72	517	331	229
Percentage bolls to flowers ..	26·7	23·0	21·5	15·1	40·0	31·0	27·9
Theoretical yield* (grammes) ..	2,026	1,633	1,071	321	2,220	1,581	1,232

* Total bolls picked × boll-weight of good bolls.

Flowering and bolling records were not kept for the four-variety trial on the granite soil, but actual yields of seed-cotton were taken from groups of fifty average plants to a plot. The results again show U.4 to be decidedly the best, but in this case A.12 and Z.1 are practically equal. As before, all three are far better than the local Bancroft. Statistical treatment of the plot figures shows the superiority of U.4 over the other two strains to be significant, with probabilities of 21 : 1 for Z.1 and 45 : 1 for A.12. Only four plots of Z.1 were used, and five each of the other two strains. The yield figures are given below, together with results from variety trials in Swaziland and Zululand for comparison. The latter figures were kindly supplied by Messrs. MacDonald and Parsons.

Locality.	*Local Variety.*		*Yields of Improved Strains (Lbs. per Acre, Seed-Cotton).*		
	Name.	*Yield.*	*U.4.*	*A.12.*	*Z.1.*
Barberton	Bancroft	335	830	674	687
Swaziland	Uganda	544	1,055	727	635
Northern Zululand ..	Zululand Hybrid	431	780	501	505

In all the experiments, covering a wide range of soils and climates, U.4 has proved consistently the best cropper. It has given, on the average, about twice the crop obtained from the local variety, and has more than fulfilled the hopes entertained of it at the end of last season. It is not anticipated that its adoption for general planting will really come near to doubling the normal yield, but there is every reason for expecting a substantial increase. A.12 and Z.1 have both done well, the former being more consistent and appearing, on all the evidence, to be the superior.

For purposes of analysis, seed-cotton was taken from the variety trial on granite soil at Barberton. A composite sample for each strain was made by taking a certain number of well-opened bolls from each plot. The following results were obtained:

	Ginning Percentage.	*Boll Weight (Grms.).*	*Weight of 100 Seeds (Grms.).*	*Lint Length (Mms.).*
U.4	35·5	4·8	9·6	29·7
A.12	34·8	5·5	9·1	29·3
Z.1	31·5	5·8	11·9	27·8

Both U.4 and A.12 give good figures for ginning percentage, and their lint lengths are good for the conditions under which the crop was grown. Samples of lint for spinning tests have been taken from the same plots, and the results should prove of interest.

Jassid Counts.—A record of the amount of infestation by jassid on the different strains was made by counting nymphs on the leaves as in the previous season. In each strain five plants from each of four plots were used, three leaves per plant, giving sixty leaves for each strain. Weekly counts of nymphs on the underside of the leaves were made over a period of ten weeks. The results are given in Figs. 7 and 8 for the two four-variety trials.

It will be seen that the local Bancroft was much more heavily infested than the three selected strains in both cases. On the granite soil (Fig. 7), where the crop was rather healthier generally, the strains remained very free from jassid throughout, the actual damage being negligible. In the experiment on the Station the crop was less healthy and jassid infestation correspondingly greater. The strains showed appreciable numbers at the peak, and suffered a small amount of damage. Unfortunately the records were started too late to show the early course of the infestation on the Bancroft. The

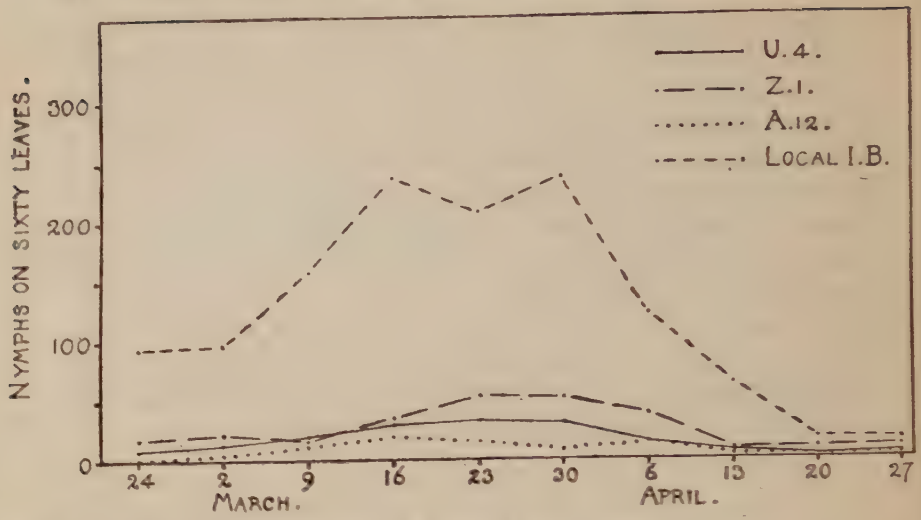


Fig. 7. Weekly jassid counts. 4-var. expt. granite soil. 20 plants, 3 leaves each.

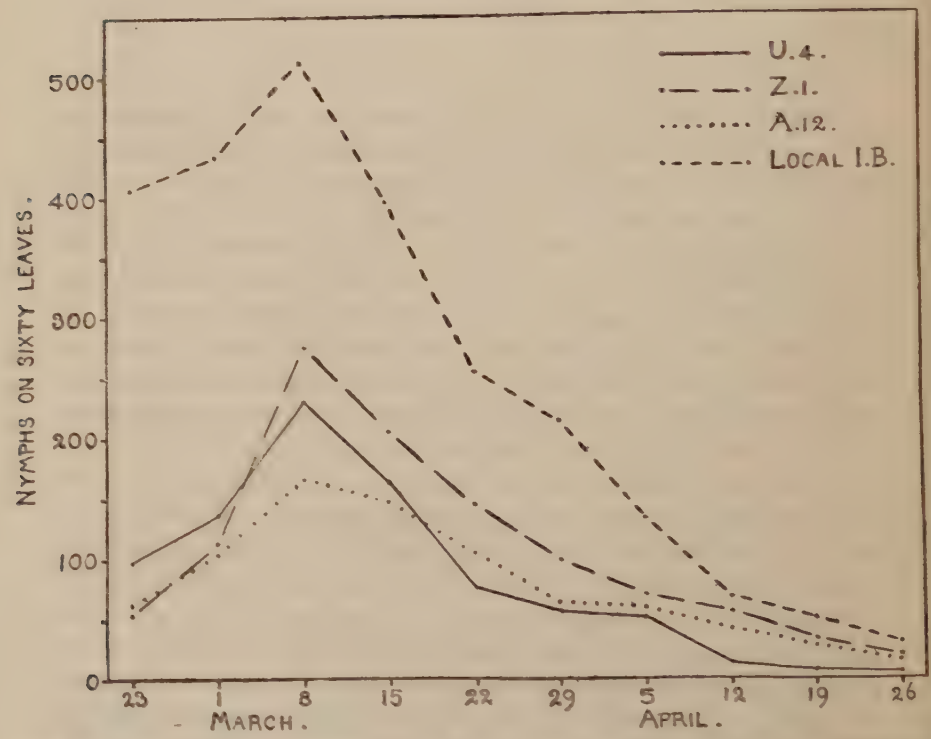


Fig. 8. Weekly jassid counts. 4-var. expt. Cotton Breeding Station. 20 plants, 3 leaves each.

figures were very high from the outset, and it is probable that they would have continued high for a longer period if the leaves had not been very badly damaged. The crop was pulled down enormously, as may be judged from the fact that bolling records indicate a yield only one-fifth of the average for the three strains. Of the three strains, A.12 consistently showed the least infestation, and U.4 rather less than Z.1.

Quality of Seed.—A matter of some importance in connection with variety trials is the possible influence, on the subsequent growth of the plant, of the quality of the seed planted. An examination of the seed of different strains to be tested showed a good deal of variation in quality, due to their having been grown under varying conditions in the previous season. In order to level up the seed as much as possible, it was all treated with sulphuric acid, and everything that floated in water was removed. The differences in the percentages of good seed remaining were considerable, and indicated the desirability of such treatment. Unfortunately the amount of water-sinking seed was not sufficient, and some spirit-sinking seed (*vide* below) had to be used in addition. In the ordinary way such poor seed would not be used for experimental purposes, but occasions arise when there is no choice in the matter.

A definite experiment to throw some light on the question was carried out by separating several qualities of seed from the same pure strain. A bad sample of Z.1-9 seed was treated with acid and the water-sinkers separated. The water-floating seed was treated with methylated spirit, and it was found that a large proportion of the seed that sank in spirit was germinable. Four classes were separated, 1 and 2 being large and small water-sinkers, 3 and 4 being dark-coated and light-coated spirit-sinkers respectively. The water-sinkers were all put through spirit to give the same treatment to all.

The four classes were planted on replicated plots for observation and records. The plots had to be replanted on new land after hail, and the growth and general development were poor. In addition, a good deal of damage to the stand was caused by white ants, and occasional measurement plants had to be changed during the course of the season. For each class forty plants were measured weekly, ten plants from each of four plots. There were heavy losses in Class 4, light-coated spirit-sinkers, and this batch finished up with only twenty-eight measurement plants. The material was not thoroughly satisfactory, but the results clearly indicate that the matter is worth following up. The table that follows gives the figures for some of the points noted.

Class of Seed.	Weight of 100 Seeds (Grms.).	Germination Percentage in Field.	Growth in Centimetres.		
			Height at 36 Days.	Mean Weekly Increment (36 to 64 Days).	Final Height at 145 Days.
1	12·5	81	13·6	4·1	62·9
2	9·2	80	11·9	3·6	61·0
3	10·3	31	10·2	3·3	62·3
4	8·5	22	8·9	3·0	55·6

It will be seen that the better seed definitely gave the better growth in the early stages. This was consistent for the first ten weeks, but after this time the order gradually changed, and at the end of the period, for the last five weeks, the increments made were in the reverse order. It is uncertain whether, under good conditions, the differences due to a better start would go on increasing, or, as in this case, would tend to be levelled up. An attempt will be made to get further information on the point in the coming season.

Seed Multiplication and Distribution.

As already stated, the multiplication of U.4, A.12, and Z.1 was pushed as rapidly as possible owing to the very urgent demand for seed of jassid-resistant strains. For this purpose the available seed was planted thinly on as large an area as possible. The seed was decidedly poor, owing to the previous season's drought, and thin stands were anticipated. Heavy storms shortly after planting still further reduced the stand in a number of cases, and many plots were completely destroyed. The plots that remained, however, gave far better yields than could have been expected from their condition early in the season, and the multiplication was reasonably good.

A.12.—The whole of the A.12 was planted by Mr. Andrews on his own farm. It promised very well, and would have given a big crop if it had not been damaged very severely by American bollworm. As a result of this damage the yield was much less than it should have been, but about 16 tons of seed were produced.

Z.1.—About one ton of Z.1 bulk seed was distributed to growers in the district, with no restrictions as to seed-rate or disposal of the seed produced. The re-selected Z.1, nearly one ton, was distributed in smaller quantities to be thinly planted for seed purposes. Considering the conditions, the yields obtained were satisfactory, amounting to 1,000 lbs. per acre of seed-cotton in one or two instances. The total amount of seed produced was just over 28 tons.

U.4.—About 475 lbs. of U.4 bulk seed were obtained from the previous season's plot. Nearly half of this was sent out for multiplication or trial plots outside the district, including a few small lots to places outside the Union. The remainder, 250 lbs., was distributed in small lots for hand-planting to a number of growers in the district. The stands obtained were particularly poor, and many plots had to be abandoned, but those that survived did very well indeed. The soils and conditions varied considerably, with corresponding variations in the amount of growth produced, but in all cases, whatever the size of the plant, the fruiting was excellent.

As an illustration of this prolific habit a photograph is given (Plate III.) of a fruiting branch carrying 20 bolls. Of these, 17 opened well and 3 were too late to be good. It will be seen that 6 bolls were produced on small supernumerary side branches. A somewhat common occurrence, where the crop received a good rain after drought, was the production of a group of bolls, very close together, at the end of a vegetative branch. Plate IV. shows an extreme case of this nature in which 13 bolls were bunched together at the tip of a big vegetative branch. It is not suggested that this is a desirable character, but it illustrates the remarkable readiness to produce fruit that is characteristic of the strain.

Only eight multiplication plots came through without being washed out. Their yields are given in the following table, together with short remarks on the conditions.

U.4 MULTIPLICATION PLOTS.

Plot.	*Seed (Lbs.).*	*Acres.*	*Yield in Lbs. Seed Cotton.*	*Yield per Acre.*	*Remarks.*
1	17	2¾	1,277	464	Very bad stands and conditions.
2	15	1½	877	585	
3	20	4	2,249	562	Severe bollworm infestation.
4	26	6½	5,696	876	Very bad stands, but fair conditions.
5	15	2¼	2,099	933	
6	20	2½	2,640	1,056	Poor stand, fair conditions.
7	6	1½	2,020	1,347	Fair stand, irrigated.
8	15	2¼	3,275	1,455	Fair stand, irrigated.
Total ..	134	23¼	20,133	866	

The first three plots stood no chance of giving good crops, owing to the conditions noted. In spite of this, however, their average yield, 534 lbs. per acre, is equal to an ordinary good average crop. The growers concerned were quite satisfied that the local variety, under

like conditions, would have given them practically nothing. The remaining five plots gave very satisfactory yields in spite of their thin stands combined with wide spacing.

The plots as a whole attracted a good deal of attention, more from the manner in which the plants fruited than from the actual acre-yields obtained. The total amount of U.4 seed produced was just over 6 tons, a good result from 1 lb. of original seed after two seasons' multiplication.

Distribution.—The interest aroused by the above strains led to the receipt of very large numbers of applications for seed. It was found that practically no other cotton would be planted in the area, and the intention of the farmers was to make the most of the jassid-resistant seed they could get by planting at a low seed-rate. It had been intended originally to issue only one strain, whichever had been most successful in the past season, but in the circumstances it was decided to distribute all three.

All growers were prepared to plant U.4 at a seed-rate of 5 lbs. per acre, and it is being issued on this basis, in lots of about 50 to 200 lbs. each, to well over 100 applicants. The area planted should be about 2,000 acres in the district and the near neighbourhood.

A.12 and Z.1 are being issued in larger quantities for planting at 10 lbs. per acre, one or the other, but not both, being issued to any one grower. The greater part of the needs of the district is being supplied by Z.1, of which there should be about 4,000 acres planted. Mr. Andrews is very kindly supplying A.12 seed to supplement this, and there should be about 1,000 acres of this strain planted. It is possible that a considerable amount of Z.1 bulk, over which no control was exercised, will also be planted in the district, but the area is not yet known. Several tons of Z.1 seed are also being distributed outside the area.

Mention must be made here of the invaluable assistance given by the Barberton Co-operative Cotton Co. in the matter of seed multiplication and distribution. The whole of the distribution has been undertaken by the Ginnery, both to its members and outsiders alike, and the extra work entailed has been carried out most willingly and efficiently by the staff.

Bollworm.

There was little bollworm of any sort during the year, what there was being almost entirely the Sudan bollworm, *Diparopsis castanea*. Three patches of ratoon cotton, of about one acre each, were left and treated as traps. They were stripped of all flowers, bolls, and large

squares at intervals of about three weeks to a month, whenever larvæ of any size could be found in them. This treatment presumably did some good, but it cannot be assumed that the general freedom from bollworm later in the season was the result of the treatment.

An attempt was made to find out if it would be possible to keep a record of the incidence of bollworm throughout the season by the regular counting of eggs on a number of plants. Eggs were first found early in October, in very small numbers, and from that time a weekly count was made of eggs on fifty marked plants in each of two plots of ratoons. The eggs were removed as they were counted. The method was satisfactory, in that it gave consistent results for the two plots, but the labour involved was too great in proportion to the results obtained, and it was given up after a few months.

An easier, though still rather laborious, method was to pick flared squares daily from whole plots with large numbers of plants. All bolls were removed at the beginning and flowers were removed daily, so that the larvæ hatching would go into squares only. Some would be missed through their entering large buds that would flower instead of flaring, but it appeared likely that the figures would give a useful record. The flared squares picked were examined, and only punctured ones were counted. The results obtained were consistent for different plots, but the numbers were very small and could not be taken to mean much from the point of view of seasonal variation. The highest peak was about the middle of January, when, for the worst week, an average of about one larva per day was obtained from fifteen plants.

ROTATION CROPS.

As in previous seasons, small plots of a number of possible rotation crops were put in for observation purposes. These were all planted about the middle of December, in fairly good conditions, and most of them made a good start. The plots were on a temporary piece of land that was not protected by drains, and a good deal of damage was caused in some cases by wash during the heavy rains at the beginning of January. On the whole, however, the crops did well and formed an interesting collection.

Pulses.—The abundance of moisture during their early growth suited the pulse crops very well, and they all made good progress. They stood the dry spell in February and March better than might have been expected, but it resulted in some of them ripening off rather too quickly to give really good yields.

The best of the lot was Tepary Bean, *Phaseolus acutifolius*, a small early type that was harvested well under three months from planting.

This gave 1,473 lbs. per acre from a quarter-acre plot somewhat damaged by wash. The season suited it perfectly, but it was an excellent yield for a plant of so small a size and short duration.

Soy Beans did well, giving a yield of 1,020 lbs. per acre from half an acre, in spite of their ripening off rather too quickly. It was noticeable that there was very little shattering, even though the crop was dead ripe when harvested.

Cowpeas started very well indeed and made an excellent cover. They were rather touched by the dry spell later and also by jassid. Of the two varieties grown, Brabham and Iron, the former was less affected by jassid, and gave 1,016 lbs. per acre of seed, as against 817 from Iron.

Velvet Beans, *Stizolobium sp.*, gave a good cover, but were slower than cowpeas and rather more affected by the dry weather. Two varieties gave yields of seed of 1,012 and 871 lbs. per acre from quarter-acre plots.

Mung, *Phaseolus mungo*, was disappointing this season. It put on a large amount of coarse growth, and flowered rather poorly and late. Beetles ate off the flowers to a large extent, and the yield of seed was poor. It would have made an excellent fodder or green-manuring crop, however, as it produced a heavy weight of green stuff.

Sword Bean, *Canavalia sp.*, grew well, but very slowly, especially during dry conditions, and took a very long time to mature its seed. It gave a big yield of 1,516 lbs. per acre, but its duration is too long for it to fit in well as a rotation crop in cotton-growing.

Cereals.—Bullrush Millet, *Pennesetum typhoideum*, was grown again and did well, but there is no local demand for the seed and little hope of exporting it profitably. In the circumstances the trials of this species are not worth continuing.

Maize was planted on various plots, mainly for silage. Early plantings did well, and some of these were left for grain and gave a good yield. Later plantings were ruined by the dry period and gave too little growth to be of any use, even for silage.

Kaffir Corn, *Sorghum vulgare*, was not as successful as had been hoped. The heavy rain when it was young appeared to be too much for it, and, as with the cotton, good growth did not start till the conditions were getting drier. Four local varieties all made rather poor growth; the Indian varieties, mentioned in the last report, grew too much. Aphis did a good deal of damage in the latter half of March. All varieties appeared to be attacked about equally, but the local varieties suffered most owing to their more advanced stage. All the yields were very poor, and the best local variety gave only 435 lbs.

per acre. Several of the Indian varieties were very late and will be discarded; of the earlier ones there were several quite promising, though they only gave a little over 600 lbs. per acre.

Another batch of Kaffir Corn strains was planted with seed very kindly supplied from the Transvaal University College. These were planted too late to do much good, and were badly infested with aphis. There were several strains, however, early and with good heads, that looked promising.

The local market for this grain is very uncertain, and for its widespread cultivation on a large scale an export market would be essential. For this reason a white-seeded variety with a bold grain is desirable, and more particular attention will be paid to such types.

Oil Seeds.—Groundnut varieties from a number of different places were tried again, but with very disappointing results. The crop started well, but *rosette* disease appeared at an early stage. All the first affected plants were carefully removed and destroyed, but this did not check the disease, and the whole crop was very badly affected. There appeared to be no differences between the varieties as regards susceptibility to the disease. The yields from the bunch varieties were better than from the runners, but all were very poor. If such attacks of rosette are likely to occur commonly there does not appear to be much hope of groundnuts being a good crop for the area.

Sunflower was the most successful crop grown during the season. Two varieties were planted, black and grey-striped, and they gave yields of 1,921 and 1,725 lbs. per acre, respectively, from quarter-acre plots. The spacing, 3 feet between rows and 9 inches in the row, appeared to be much too close, and a wider spacing would probably have given even better results. This is a very easy crop to grow, requires little attention, and is a good cleaning crop. The thrashing on a large scale should present no difficulty if proper machinery were used. The price obtained for the seed is rather unsteady, but, making due allowance for this, the crop shows promise of being a useful one for the area.

Miscellaneous.—Of other crops tried, the only one worthy of mention is Sunnhemp. This grew very well, and would have given a good crop of fibre had it been required for that purpose. It was left for seed, however, and produced a heavy crop of about 1,000 lbs. per acre. It is unlikely that this crop would be grown for fibre, except in special areas where water for retting might be available, but it is an excellent green-manuring crop for the area, and is coming into use for that purpose.

Expansion of Station.

The Station was enlarged by the addition, towards the end of the season, of a new piece of land which brings the total area up to 511 acres. This area is now leased to Government by the Barberton Municipality, at a nominal rent, for so long as it may be required for an Experimental Station. The whole has been fenced, and a block for cultivation, giving about 150 acres of actual fields, has been fenced off from the grazing area. This block has been stumped and cleared, and the bulk of it was ploughed towards the back end of the season. Part of the remaining land is granite soil, and a further block on this side will be fenced off for cultivation later. It will be of value to have this soil, in addition to the red loam of the main area, in order that results on the two different soils may be compared as required.

The new area is good level land, if anything rather better than the old, and with slightly less slope. It will be laid out in long narrow fields, with the greatest slope across the width, and with large shallow drains to catch any run-off. It is hoped in this manner to avoid any serious damage from wash. It means sacrificing a good deal of land for roads and drains, but the problem of wash is not one to be dealt with lightly.

A laboratory giving ample accommodation for a considerable expansion in the work is now being built in the centre of the Station. The existing well is quite close to this site, and a small power pump will be put in to supply all requirements. It will be possible to irrigate a small plot near the well if this becomes necessary at any time for safeguarding special plants.

Quarters for Staff are being built at the end of the town well up from the Station. It is a good site, where municipal services can be obtained, and at the same time is only two miles from the laboratory. Two larger houses are nearly completed, and two smaller ones will be started shortly.

DAILY RAINFALL, SEASON 1927-28

	July.	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May.*	*June.*
1	—	—	—	—	0·02	0·87	1·42	—	—	—	—	—
2	—	—	—	—	—	0·07	—	—	—	—	—	—
3	—	—	—	—	0·09	0·08	—	0·02	0·40	—	—	—
4	—	—	—	—	—	0·02	—	0·16	—	—	—	—
5	—	—	—	—	—	—	1·44	—	—	—	—	—
6	—	0·02	—	—	—	—	0·72	0·78	—	0·86	—	—
7	—	—	—	—	—	—	—	—	0·10	0·14	—	—
8	—	—	—	—	—	—	—	0·21	—	0·05	—	—
9	—	—	—	—	—	—	—	0·01	0·13	—	—	—
10	—	—	—	—	—	—	—	—	0·05	—	—	—
11	—	—	—	—	—	0·27	0·48	—	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	0·17	—	—	—	—	—
14	—	—	—	0·49	—	0·17	0·24	—	0·92	—	—	—
15	—	—	0·38	0·45	—	—	0·02	—	—	—	—	—
16	—	—	0·12	0·33	—	—	1·01	—	—	—	—	—
17	—	—	—	0·33	—	0·01	0·35	—	—	—	—	—
18	—	—	—	0·05	—	0·04	0·04	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	—	—	0·05	—	—
21	—	—	—	0·01	—	0·02	0·03	0·07	—	—	—	—
22	—	—	—	—	—	0·02	—	—	—	—	—	—
23	—	—	—	—	—	—	0·07	—	—	—	—	—
24	—	—	—	—	0·45	—	—	—	—	—	—	—
25	—	—	—	0·02	0·21	—	—	—	—	—	—	—
26	0·51	—	—	0·46	1·39	—	—	0·01	—	—	—	—
27	0·24	—	—	0·68	0·04	—	1·02	0·06	—	—	—	—
28	0·19	—	—	1·08	—	—	0·02	0·03	0·11	—	—	—
29	—	—	—	1·48	—	2·50	0·43	—	—	—	—	—
30	—	—	—	0·13	—	0·96	0·04	—	—	—	—	—
31	—	—	—	—	—	0·03	—	—	—	—	—	—
Total	0·94	0·02	0·50	5·51	2·20	5·06	7·50	1·35	1·71	1·10	—	—

Total rainfall for year, 25·89 inches.

DAILY RAINFALL. SEASON 1927-28.

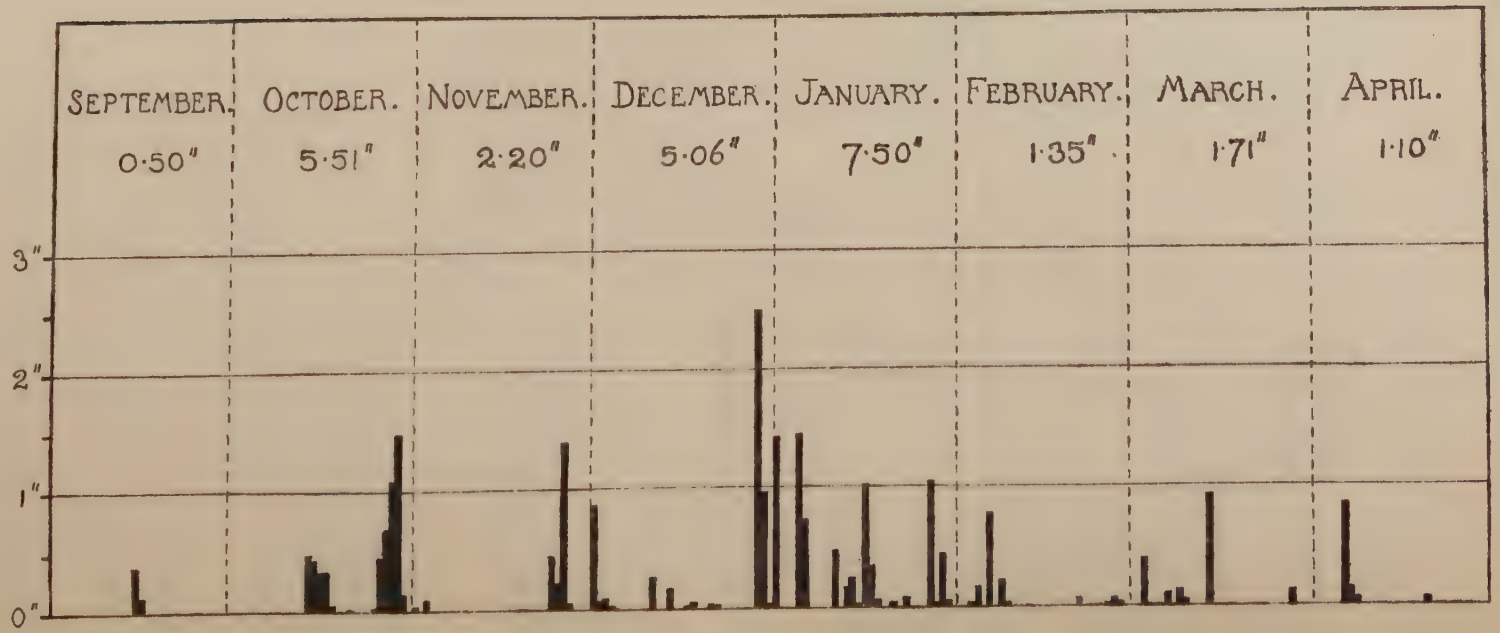


PLATE I.—A U.4 SELECTION, AFTER FINAL PICKING, SHOWING PROLIFIC HABIT AND GOOD SHAPE.

PLATE II.—A U.4 SELECTION OF ABOUT AVERAGE STANDARD: COTTON REPLACED IN BOLLS AFTER FINAL PICKING.

PLATE III.—A GOOD FRUITING BRANCH FROM A U.4 PLANT CARRYING 20 BOLLS.

PLATE IV.—A CLUSTER OF 13 BOLLS FROM THE END OF A LARGE VEGETATIVE BRANCH OF U.4.

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATION, CANDOVER, MAGUT, NATAL, FOR THE SEASON 1927-1928

BY

F. S. PARSONS.

Introductory.

The crop produced in the Candover District during the season amounted to some 9,000 woolpacks of seed cotton, the weight of a filled woolpack being approximately 500 lbs. This represents an increase of 28 per cent. over the previous season's output. The crop was derived mainly from ratoon cotton. Labour shortage in the early months of the season was responsible for a large reduction in the total of the ratoon cotton acreage as planned, inasmuch as it became necessary to abandon lands which were badly overgrown with weeds.

The usual rains in February and March did not fall this year, and as a result the ratoon cotton was reaped under comparatively ideal conditions and with practical freedom from stainer damage; the stainers do not invade cotton until March or later. Jassid came into the ratoon cotton in great numbers when the bolls were commencing to open. Ripening off, though frequently premature, was stimulated by the " effect " of the jassid and the increasing dryness. The jassid diminished in March, and on the whole the ratoon crop escaped appreciable damage from it. These facts and the incidence of an unusually light bollworm infestation favoured the practice of ratooning this season.

The plant cotton progressed well until the rainless period, February and March, set in (*vide* chart, Fig. 1, p. 57). In March it appeared that all but the most advanced bolls would shed. Actually deeper rooting brought these crops in contact with moisture, which, observation showed, existed below as a result of the saturation of the soil experienced in December. The fact that the plant cotton did yield fair crops in many instances meant a great deal to the cotton industry here, as much depended on securing a large quantity of seed from the various multiplication fields of jassid-resistant cotton strains.

The further programme of seed multiplication was briefly referred to in last year's Report. This was carried out, and the results are tabulated in another section. The Corporation's Officers have been given every assistance by the farming community in multiplying Parnell's strains, so that the seed might be available in commercial quantities with the minimum of delay. This has been accomplished, and thanks are due to the farmers who accepted the initial very small weights of seed somewhat on trust as to its merits, and, at considerable expense, devoted some 350 acres of land to be sown by hand with single seeds a yard apart. Fortunately, during last season, methods of planting small quantities of seed through the planting machine worked well, and it was possible to plant out 1,000 acres of the re-selected Z seed and some 300 to 400 acres of Z1-bulk.

Staff.

Mr. A. P. Bowmaker joined his appointment at the Candover Experiment Station in early November, 1927.

Buildings and Equipment.

A compound has been erected for the housing of native labour.

A building 40 by 25 feet is under construction. This will be a three-roomed structure providing a laboratory and seed-storage facilities. A small brick fumigation building has been completed.

The Station is now equipped with draught oxen and a range of implements, whereas formerly these were secured on hire.

Extension of the Experiment Station.

The cultivated area has been increased by 50 acres. This land is an extension of the former Experiment Station block. In addition to this, 100 acres of wooded pasture on the Experiment Station boundary have been alienated for our use.

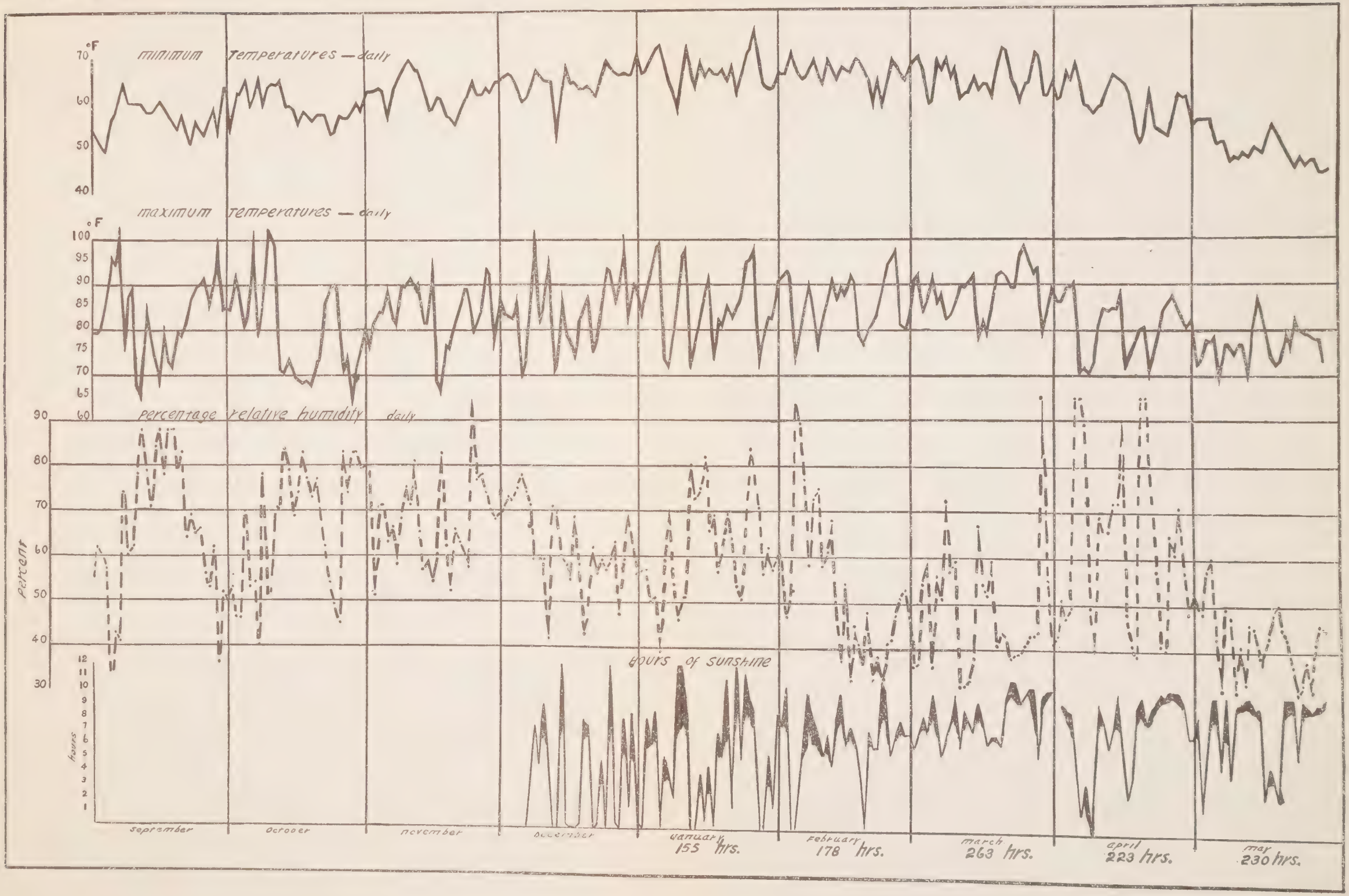
Climatic Conditions.

The total effective rainfall for the season was 23 inches as against 13·8 inches for the previous season. The daily rainfall is shown graphically in Fig. I. The outstanding feature of the distribution for the season was the rainless period from February 8 to March 28. As a result of plentiful moisture from the middle of October to the first week of February, the plants (plant cotton) were large, soft, and vegetative, but carrying excellent crops. There had been no definite

CANDOVER

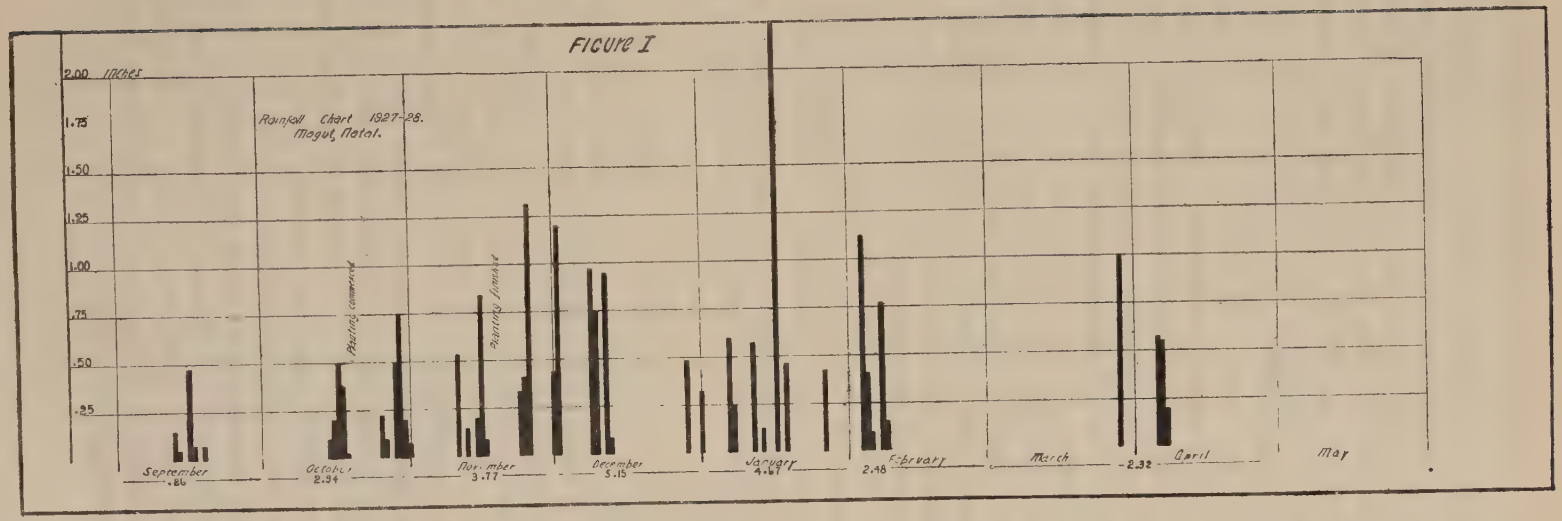
FIGURE II

Temperature, Humidity, and Sunshine Chart, 1927-28



CANDOVER

RAINFALL CHART, 1927-28



check in growth and no incentive to root deeply, so that they could not develop the fruit borne when the surface moisture was depleted in February and March, nor could they retain much of the crop that seemed assured. The hot, dry conditions of February and March were greatly aggravated by periods of high wind which attained violence at times over the unsheltered lands, again emphasizing the need of shelter belts.

The distribution and volume of the November-December rain were sufficient to produce waterlogging in the shale loams and other soils which shallowly overlie layers incapable of absorbing water quickly. The soil erosion and crop damage were pronounced at this time, and reached an extent for which the previous dry seasons had not prepared us.

Cold, cloudy days were features of the early seedling period. During the cold period a form of damping-off was widespread. Irregularly low temperatures were experienced in December, the maximum temperature being frequently under 70°. The effect of this on growth was apparent.

The above and other aspects of the climatic conditions during the season are brought out in the meteorological data charted in Figs. I. and II.

The low humidity in February and March is associated with the delay in *Dysdercus* (stainer) movement into cotton as discussed later.

Seed Multiplication.

9,161 lbs. of seed were secured from the first season's multiplication of the jassid-resistant cottons produced at Barberton; 6,000 lbs. of this seed were derived from the four strains known as Z1-9, Z1-14, Z1-15, and Z1-24. These required to be multiplied as far as possible and the identity of the strains maintained. In tests at Barberton, during the 1926-27 season, Z1-24 was found inferior to the standard of comparison, Z1-bulk, and discarded (" Report on the Work of the Cotton Breeding Station, Barberton, 1926-27 "). In view of its jassid-resistant qualities, however, Z1-24 was multiplied again in 1927-28 at Candover, as it represents an advance over the ordinary cottons in other ways.

The remaining 3,161 lbs. of seed were derived from Z1-bulk, the " parent " material of the above ("Report on the Work of the Plant Breeding Station, Barberton, 1925-26 "). This was given to farmers for their multiplication and use pending the accumulation of sufficient supplies of improved seed.

The whole of the 9,161 lbs. of seed was distributed for multiplication during the season under review.

In addition to these, 90 lbs. of U4 bulk and some small weights of seed built up from selfed material, obtained in the above and other numbered Z strains, were set out for multiplication and testing.

The acreage sown with the Z seed has been given (p. 56). Hail on December 2, pest damage, and washing out reduced the 1,000 acres to approximately 750 acres.

The Z cottons made excellent growth and were bearing well when the late season drought intervened; they then shed heavily, particularly in the best stands; with more root room plants were better able to retain their crops. Readjustment of the plants from deeper rooting occurred, and the final yields were higher than anticipated. The full ginning return of seed is given in Table I. The Corporation's Officers supervised the ginning and the labelling of the seed.

Thanks are due to Mr. F. G. Penhall, Manager of the Candover Ginnery, for the care exercised by him in the work of removing sources of seed contamination in the ginnery.

TABLE I.

GINNING RETURN OF MULTIPLIED SEED.

JASSID-RESISTANT COTTONS, SECOND MULTIPLICATION, CANDOVER.

Seed Designation.	*Weight of Seed (Lbs.).*
Z1-14	64,922
Z1-9	21,385
Z1-15	31,296
Z1-24	20,804
Z1-bulk	71,728
U4-bulk	3,900
Selfed Z strains	1,823
	215,858

The Z1-bulk seed remains in the hands of the growers and will be planted next season, but thereafter this seed will be supplanted by better material from the improved strains. Under a pool arrangement, the seed of the numbered Zs, above, has been redistributed at 2d. per lb., on behalf of the growers who multiplied the seed, to associations of cotton-growers or individual growers in areas where jassid is a determining factor. The area sown with the seed will probably exceed 14,000 acres, so that a sufficient supply of special Z seed is assured.

The yields from the better multiplication areas were decidedly superior to the yields of commercial stands of ordinary Zululand

hybrid or Improved Bancroft plant cotton, and where these or other ordinary cottons were advantageously situated for comparison with Z cottons the superior vigour of the latter was marked. U4 proved of outstanding merit everywhere it was grown; its comparative yielding power and its earliness are brought out well in the results of a variety test reported later.

A small quantity of seed from Z106, a type particularly poplar-like in habit, was set out for observation together with U4 and A12 in some of the driest tracts in Zululand. These three cottons have been described and illustrated in the last Report from Barberton, and were chosen as being perhaps the most drought-resistant of the jassid selections. At Pongola Poort the rains of the first half of the season were short, and with the arrival of the rainless period in the late season, plant cotton there was subjected to conditions under which it did not seem that cotton could survive. At a time when U4 and A12 were past recovery Z106 was green and flowering. On the face of things, Z106 appears to possess unusually high drought-resisting qualities, and may prove of great value in some areas if the case is proven.

Cambodia Selections.

Half of the seed from the most promising selections made in the previous season was sent to the Plant Breeding Station at Barberton. The other half was sown at Candover for further observation. As the Cambodias suffered in a very severe hailstorm at Barberton, it became of greater importance to study the material at Candover closely with a view to further selections, as it represented the major portion of the available stock.

Twenty-three single-plant lots have been retained from the re-selections made, including some rather extreme forms. The previous selections were made with a view to securing earliness and compactness, a better lint length and less harshness of the lint. A decided advance has been made along these lines.

In Table II. are given the data on boll, lint, seed, and other characters for some of the best of the re-selections. These re-selections will be grown again in progeny rows.

Six of the best progenies were bulked individually with a view to multiplication and further testing. These will be grown also elsewhere where conditions are somewhat different. Commercial samples of lint from the hand roller gin were sent to the Union Cotton Grader, and his descriptions are given in Table III., which gives the analyses of the bulked progenies.

PLATE I.—107 TONS OF SEED: SECOND MULTIPLICATION OF JASSID RESISTANT COTTON (CANDOVER)

PLATE II.—CAMBODIA—C.S-7-7-1

TABLE II.

CAMBODIA SELECTIONS.

Plant Number.	*Mean Boll Weight (Grms.).*	*Bolls to a Pound of Seed Cotton.*	*Weight of Seed Cotton Reaped (Grms.).*	*Ginning Percentage.*	*Lint Index.*	*Mean Lint Length (Mms.).*	*Weight of 100 Seeds (Grms.).*
C8-7-7-4 ..	6·6	68·8	202·7	31·2	5·7	30·0	12·3
C8-1-12-3 ..	7·1	64·0	193·6	32·7	6·4	30·0	13·2
C8-1-5-1 ..	7·2	63·0	170·8	30·5	6·0	28·0	13·7
C8-33-36-1 ..	6·5	70·0	103·4	32·8	6·0	28·0	12·3
C8-1-9-1 ..	8·1	56·0	197·7	32·8	7·3	29·0	15·1
C8-7-22-3 ..	6·4	71·0	72·4	31·5	5·4	27·5	11·7
C8-9-7-1 ..	7·1	64·0	117·2	33·7	6·4	28·0	12·6
C8-20-4-1 ..	6·4	71·0	118·5	30·1	6·1	28·2	13·9

TABLE III.

CAMBODIA BULKED PROGENIES.

Cambodia Bulk Number.	*Mean Boll Weight (Grms.).*	*Bolls to a Pound of Seed Cotton.*	*Mean Weight of Seed Cotton per Plant.*	*Ginning Percentage.*	*Lint Index.*	*Mean Weight of 100 Seeds (Grms.).*	*Mean Lint Length (Mms.).*	*Commercial Grading.*
C8-1-5 ..	6·87	66·1	166·0	31·1	5·9	13·1	28·5	S.M. full $1\frac{1}{8}$"
C8-7-22 ..	6·2	73·2	94·7	33·1	5·6	11·2	28·7	S.M. $1\frac{3}{16}$"
C8-9-83 ..	6·5	70·0	78·2	33·2	6·3	12·5	28·5	S.M. full $1\frac{1}{8}$"
C8-1-9 ..	7·4	61·3	166·3	32·2	6·5	13·8	29·2	" "
C8-7-7 ..	6·3	72·0	142·4	31·4	6·8	12·9	29·8	S.G.M. $1\frac{1}{4}$"
C8-20-4 ..	6·7	67·7	94·2	29·7	5·9	13·8	28·7	S.M. $1\frac{3}{16}$"

EXPERIMENTAL WORK.

The growing conditions were decidedly better than during the previous two seasons, and the work was carried out according to plan for the first time.

TEST OF SELFED Z STRAINS.

One-acre multiplication blocks of the following were set out on the Experiment Station:

Z1-5
Z1-25
Z1-15
Z1-9
Z1-14

Z1-5 and Z1-25 had not been grown in the area before. The seed planted had been multiplied from selfed seed, and further tests of these strains were required.

Results from the plot test of these, with the exception of Z1-14, are given in Table IV. and Table V. Unfortunately the provision of Z1-14 seed for the comparative trial was overlooked. The Z1-9 which went into general multiplication last season was adopted as a standard for comparison, as for certain reasons it seemed probable that this strain would ultimately be chosen as the best of the Z cottons. The plots were laid out with the standard on each side of the strains that were being tested against it and against each other, so that comparisons could be made adjacently on the half-drill-strip method. Seed was available for triplicated plots only, giving, therefore, six comparisons with the standard. The plots were set out as $\frac{1}{40}$ acre each, but owing to erosion a straight cut was taken through the plots, reducing them to $\frac{1}{80}$ acre.

TABLE IV.

TEST OF SELFED Z STRAINS.

Strain.	*Yield (Lbs. per Acre).*	*Yield as Percentage of Standard.*	ϵ_d	$\frac{\bar{d}}{\epsilon_d}$	*P.*	*Significance.*
Z1-9 (old) (standard) ..	394	—	—	—	—	—
Z1-9 (selfed) ..	387	98·2	83·0	0·25	0·803	Nil.
Z1-15 „ ..	394	100·0	55·0	0·018	0·976	Nil.
Z1-5 „ ..	342	86·8	34·3	4·4	—	Very highly significant.
Z1-25 „ ..	354	89·8	56·1	2·10	0·036	Significant.

ϵ_d=Standard error of mean difference.

$\frac{\bar{d}}{\epsilon_d}$= Ratio of mean difference to standard error.

P.=Probability integral.

TABLE V.

Strain.	*Mean Boll Weight (Grms.).*	*Bolls to a Pound Seed Cotton.*	*Ginning Percentage.*	*Lint Index.*	*Weight of 100 Seeds (Grms.).*	*Lint Length (Mms.).*
Z1-9 (standard)	5·2	87·1	30·4	5·02	11·5	26·4
Z1-9 (selfed)	5·2	87·1	30·0	4·97	11·6	26·2
Z1-15 „	5·15	88·1	30·0	5·06	11·8	26·9
Z1-5 „	5·0	90·8	33·7	4·98	9·8	25·8
Z1-25 „	5·05	89·9	29·4	4·66	11·2	26·5

There appears to be no difference between the standard, Z1-9 (selfed) and Z1-15 (selfed), whereas the other two are significantly inferior in yield, and in the case of Z1-5 some inferiority in lint length and boll weight, though slight, exists. During growth it was impossible to distinguish between the strains. In the next season Z1-14 will be included in a test against Z1-9 and Z1-15.

The plots were picked at weekly intervals from March 28 until April 25, with a final picking on May 8. The percentage of crop picked at each date is given in the following table:

TABLE VI.

PERCENTAGE OF CROP PICKED AT WEEKLY INTERVALS.

SELFED Z STRAINS.

Strain.	*March* 28.	*April* 4.	*April* 11.	*April* 18.	*April* 25.	*May* 8.	
Standard ..	24·7	18·8	14·5	23·1	9·8	9·1	100 per cent.
Z1-9 (selfed)	15·3	16·8	13·4	26·1	16·3	12·1	—
Z1-15 „	20·1	20·5	16·2	26·7	7·5	9·0	—
Z1-5 „	21·5	19·0	14·2	27·7	10·5	7·1	—
Z1-25 „	18·6	15·6	15·6	29·5	11·8	8·9	—

The standard (Z1-9) is seen to be somewhat earlier than the others, the selfed Z1-9 being a little the latest.

Z106 SPACING TRIALS.

Z106 is a very close, upright type which would seem to be well adapted for close spacing in the drill, and to do well if the inter-row distance is reduced. The seed available was a mixed bulk quantity of only a few pounds, so that a number of treatments could not be carried out. Two experiments were tried in which the drill interval was 6 inches in each case, but in one case the inter-row distance was reduced to 2 feet 6 inches, and in the other 3 feet, as against the usual 3 feet 6 inches adopted for other cottons. The standard of comparison was Z1-9 at 12 inches in the drill and 3 feet 6 inches across the rows. These plots were laid out with the standard on each side of Z106, in quadruplicate for the 2 feet 6 inches treatment, and in triplicate for the other owing to the shortage of seed. There were, however, eight comparisons with the standard in the first case and six in the second. It was necessary to introduce guard rows 3 feet apart between the standard and Z106 in order partially to offset the edge effect introduced by the difference in width between the rows of the two cottons. The experiment would have been better had it

been set out in a Latin square or other arrangement, as the half-drill-strip method allows a large type to overbear on the side of a smaller or different type of cotton plant, and the difference in this case between the thin upright Z106 and Z1-9, a large shrubby plant, was marked. The plots were $\frac{1}{40}$-acre areas, this being the size of plot adopted for most of the cotton experiments. The results are given in Table VII.

TABLE VII.

Z106 Spacing Trials.

Strain.	*Spacing.*	*Yield (Lbs. per Acre).*	*Yield as Percentage of Standard.*	$\frac{\bar{d}}{\epsilon_d}$	*P.*	
Standard	12-inch drill; 3 feet 6 inches row	364	—	—	—	—
Z106 ..	6-inch drill; 2 feet 6 inches row	444	121·9	4·0	0·0006	Highly significant increase.
Standard	12-inch drill; 3 feet 6 inches row	386	—	—	—	—
Z106 ..	6-inch drill; 3 feet row	353	91·4	1·8	0·075	Decrease not significant.

Mules are used with cultivators on the Experiment Station, and with these it was found that the necessary cultivation could be performed without damage to the plants in rows 2 feet 6 inches apart, up to the time the cotton is generally "laid by." It should be possible to cultivate Z106 at this width of row with steady oxen and leaders without undue damage.

The rows of Z106 were narrow, tall, and very hedge-like in appearance. They were bearing a good crop of small bolls when the dry period commenced, but with the increasing dryness rapid shedding depleted everything but advanced fruit, and much of this withered on the plant. The shedding in the standard was not so sudden and intense, but Z1-9 is not a heavy fruiting type and is later in development. The plots were planted late, and there had been no check in growth from weather conditions. When moisture grew difficult of access, in the late season, the ripening-off processes had barely begun, and the plants were more lush and less able to withstand the dry conditions than earlier planted cotton. The lint from the first picking was of good length and strength, but soft and immature in later pickings. Most of the later lint was derived from bolls which simply dried out on the plant and opened prematurely.

Drought resistance was not apparent in Z106 under these conditions, the foliage yellowing off quickly with a high degree of leaf fall.

Where the observations on drought resistance were made, however, the conditions for growth had been difficult during the whole season, and this season may be regarded as typical of the drier parts of the country. It was evident from the percentage of crop picked at successive intervals and from growth behaviour that Z106 is much earlier than the other Z strains which have been grown here. The spacing trials will be continued. Z106 is not a heavy bearing type and requires a close spacing if good yields are to be obtained from it.

Variety Trial.

The six best strains of jassid-resistant cotton and Zululand hybrid, the ordinary cotton, were tested in this variety trial, using Z1-9 as a standard.

There were six repetitions of each strain. Plots of the standard were arranged on each side of all strains throughout so that twelve comparisons could be made with the standard in each case. The plots consisted of four rows, 3 feet 6 inches apart and 80 feet long. They were laid out in three equal strips in column. Zululand hybrid was included as the commonly grown local cotton, and for comparison when jassid came into the crop.

The plots were sown with the early November rain, and the seed was put in as rapidly as possible, as observations had shown that a difference of a day in planting meant four or more days' difference in the germination of the last sown plots. In this case sowing was completed by midday of the third day, each strip being completed under much the same conditions. The first strip germinated five days before the third strip, and this meant a surprising difference in the relative ripening periods of the two.

The spacing in the drill was 12 inches throughout. This spacing was adopted as the best compromise, having regard to the difference in habit of some of the strains. The spacing actually proved to be too close under the conditions of good moisture. The plants made large, vegetative growth, and U4, which had been regarded as a small, compact plant, smaller than any of the others, grew to such a size that it was shoulder high and towered above all others.

The tables for yield and percentage of crop picked at the several reaping dates give a very good idea of the behaviour of the strains during this season. The weekly notes on these are very interesting, as they show that B143, B180, and B179 were very leafy, vegetative, soft, and decidedly late in fruiting. There was practically no crop in evidence on these three in January, and it seems quite likely that had

the increasingly dry weather not intervened and checked their vegetative growth, the yields from them would have been negligible owing to stainer damage, or at the best a very late crop would have resulted. In spite of a great deal of vegetative branching, and the size the plants attained, U4 set a good crop early in the season, and this is readily seen in the returns. Only the early set bolls were harvested, however, as the crowded plants could not carry the crop for long once moisture stringency was felt. A12 grew very close and bushy, producing a surprising number of high monopodia. This is a strain out of Bancroft, but it is much hardier, and came through the rainless period better, as the results indicate. Z49 was very leafy and ragged in appearance and very late. Jassid soon made its presence apparent in Zululand hybrid, and the unhealthy appearance of the leaves enabled the plots of this cotton to be distinguished at long distances. The position of Zululand hybrid in the table of yields is mainly due to the check administered to plant growth by the jassid, as early fruiting was stimulated before the dry weather commenced; up to the time jassid appeared the weather had been good and boll-worm very light, so that Zululand hybrid was carrying an ordinary crop.

JASSID EFFECT.

U4, B179, B143	Light jassid effect.
B180	Rather low resistance.
A12	No jassid effect.
Z49	No jassid effect.
Z1-9	Slight jassid effect.
Z.H.	Pronounced jassid effect.

Jassid effect was determined by visual observations only. It is recognized, however, that growth may be disturbed by the jassid without apparent results.

TABLE VIII.

VARIETY TRIAL YIELDS. JASSID-RESISTANT STRAINS.

Strain.	*Yield (Lbs. per Acre).*	*Yield as Percentage of Standard.*	$\frac{\bar{d}}{\epsilon_{\bar{d}}}$	
U4	780	154·5	8·4	Very highly significant difference.
Z1-9 (standard)	505	—	—	—
A12	501	99·2	0·13	—
Z.H.	431	85·3	3·33	Significant difference.
B179	340	67·3	7·0	Very highly significant difference.
B180	335	66·3	13·2	" " "
B143	344	68·1	11·2	" " "
Z49	324	64·1	8·0	" " "

TABLE IX.

BOLL, LINT, AND SEED CHARACTERS.

Strain.	*Mean Boll Weight (Grms.).*	*Bolls to a Pound of Seed Cotton.*	*Ginning Percentage.*	*Lint Index.*	*Lint Length (Mms.).*	*Weight of 100 Seeds (Grms.).*
U4	4·1	110	34·0	4·8	27·1	9·3
Z1-9	5·3	86	29·0	4·4	26·0	10·8
A12	4·6	99	29·4	4·0	27·0	9·7
Z.H.	4·2	108	28·7	3·8	25·9	9·4
B179	5·4	84	27·6	4·5	27·0	11·7
B180	5·5	83	28·3	5·7	27·5	11·9
B143	5·2	87	25·4	4·1	27·7	12·5
Z49	5·1	89	27·0	4·3	26·7	11·7

The plots were picked at weekly intervals from March 19 to April 9, with a final picking on April 23. The percentage of the crop picked for each strain at reaping dates is given in Table X. The first two pickings were much heavier in the first two or top strips than in the lower strip. At the last two reapings there was little to reap in the top strips, the reason assigned being the delayed germination of the bottom strip.

TABLE X.

PERCENTAGE OF CROP PICKED AT DATES OF REAPING. VARIETY TRIAL.

Strain.	*March 19.*	*March 26.*	*April 2.*	*April 9.*	*April 23.*
U4	20·0	34·2	28·8	8·7	8·3
Z1-9	16·9	26.8	32·1	11·6	12·6
A12	15·8	23·2	32·8	13·9	14·8
Z.H.	22·3	29·3	28·2	10·1	10·1
B179	15·7	28·3	27·7	13·6	14·7
B180	15·9	26·2	32·9	13·6	11·4
B143	11·5	21·6	26·9	15·6	24·4
Z49	10·2	30·3	32·4	10·1	17·0

The above figures give a fairly accurate picture of relative earliness, viewed in conjunction with notes on the progress of the strains until February. Jassid effect on the Zululand hybrid, as stated, stimulated this cotton to earlier ripening off.

Observation plots for all the above were set out elsewhere on different soils, and varied responses were observed which show that there is an appreciable difference in the behaviour of the strains on

other and deeper soils. During next season the softer Bancrofts will be tested under irrigation. A test of the strains has not been conducted as yet in other areas farther south where Bancroft is grown with good success. This will be done in the next season.

Time-of-Thinning Experiment.

Investigations were designed with a view to extending the preliminary work reported last year. Plots were sown according to plan in October, but the resulting stand was poor. These were resown with the last Z1-9 seed in hand, but the stand was not suitable for the purpose. It was necessary to use ordinary seed for a third sowing, from which good germination was secured, and observations were commenced on the plots. Towards the end of November and during the first week of December the soil was saturated and cold weather was experienced, as a result of which the plots became useless for the measurements required. In these plots Anthracnose and a form of damping-off became widespread, and the experiment was abandoned.

A Sub-Station was opened in Southern Swaziland in September. Time-of-thinning plots were set out there for observation purposes. Results from these are reported under the work at the Sub-Station.

Spacing Trials—Z1-9.

The spacings adopted for testing were 6, 12, 18 and 24 inches. Eighteen inches or thereabout is the usual spacing. The plots were arranged in four equal strips in column. The 18-inch spacing was adopted as a standard, and each plot of 6-, 12- and 24-inch spacings had a plot at the standard spacing on each side. The 6-, 12- and 24-inch treatments occurred once in each strip, giving four replications and eight comparisons with the standard. Each plot was intended to consist of six rows, 3 feet 6 inches apart and 78 feet long. One row on each side of every plot was intended as a guard row to offset the edge effect set up when plants in adjacent rows are spaced differently. The guard rows were cut out when picking commenced. The resulting plots of four rows equalled $\frac{1}{40}$ acre, and yields were taken from these. One plot in the 24-inch series was not taken for yield, as it covered an old ant-heap site and obvious differences were seen. Owing to an error in planting, one of the 12-inch plots could not be used. The results for these two spacing intervals are therefore taken from plots in triplicate only.

It was seen that a certain amount of edge effect occurred after the

elimination of the guard rows, late and dry as it was, so that in another season these should remain. The method of differences between closely adjacent plots was used in the calculation of standard errors.

Z1-9 seed was used. The rows were sown at the required intervals with five to eight seeds per hole, and not in continuous rows. The value of the experiment was reduced by so doing, as growth conditions were not comparable during what would be the pre-thinning period in commercial crops. The only seed available in sufficient abundance to plant continuous rows was Zululand hybrid, the ordinary local seed, and the lack of uniformity in plant form and susceptibility to jassid of this strain, was thought to be a greater evil than the relative freedom from competition at the start, of the spaced plants. Approximately 20 per cent. refilling of blanks was necessary. The plants at refilled positions were unequal to the first sown plants in growth, and a random selection for various measurements could not be made both on this account and because of plant losses resulting from beetle damage (*Syagrus rugifrons*). The plants used for flowering and other records were marked in lengths of rows which obviously did not contain second sowing plants.

Records were taken on growth, plant structure, flowering, and shedding. A rather extensive examination of the fruit characters was made also, as it had been found in a spacing experiment of a qualitative nature (1925-26 Report) that these varied in the spacing treatments to an important extent.

Growth and Habit.—The plants at 6-inch intervals rapidly attained a marked superiority in height over all others, and were conspicuous for that reason until late in February, when moisture shortage was felt in these plots; with less competition the others continued to make growth upward, and in the end the plants appeared of equal height, although this was not actually so.

The plants at 6 inches finished branching on an average at node number 20, those at 12 inches at node number 22 or 23, and the others at node number 34. The plants at 6 inches owed their superior upward growth during the first two and a half months to the production of longer internodes on the main stem and to greatly reduced monopodial development. The lateral branching at 6-inch spacing was the most pronounced in point of length. In January these plants looked overgrown, leafy, and soft. In the mass they had the appearance of bearing well and were early, the first flowers appearing seven to eight weeks after the cotyledons emerged. The plants in the other spacings showed increasingly wide basal development,

12 inches to 24 inches, due to the greater number of monopodia and to shorter internodal lengths on the main stem.

The close succession of good rains promoted surface rooting to a marked degree. When picking was completed, an examination of the rooting systems in the different spacings was made. The soil had set very hard, and as water was not available as an aid in excavation, plants were dug out with only short lengths of lateral roots. These showed the position and number of the laterals. The relative development of these is seen in Plate III.

PLATE III.—ROOT DEVELOPMENT IN SPACING TREATMENTS: DRILL INTERVALS—6, 12, 18, 24 INCHES.

The diameter of the main stem at ground level was found to be very consistent. The figures for these measurements are given below.

Spacing.	*Mean Diameter of Main Stem at Ground Level (Mms.).*
6 inches	13·35
12 „	16·55
18 „	17·70
24 „	19·05

The plants at 6 inches which appeared large and vigorous when moisture was plentiful actually had a very slender scaffolding and were deceptive. The scaffolding of plants in the other spacings was rather more extensive and rugged as the interval increased, but all were bearing too much "top-hamper," having regard to the extent and depth of rooting.

The yields arose from a combination of the age of bolls in relation to drought evasion and shedding, earliness as stimulated by plant

competition, and the relative bearing surfaces of plants at the different spacings. Data are given in the flowering and shedding curves which show some of these relationships.

The yields are given in Table XI. The somewhat lower figure for the 12-inch treatment is ascribed to greater plant losses in the stand.

Shedding Records.—The shedding records were taken from daily morning collections of shed material on the ground under rows. An index to shedding behaviour in the different spacings was sufficient for comparative purposes, and the method of record served this purpose. The data are given in Fig. III. (p. 72) as bolls shed per plant per day and per unit area, computed as five-days averages. The shedding includes bud shedding, so the curves might better have been called simply shedding curves. Records were commenced on January 19, as a good deal of shedding was observed, particularly in the 6-inch spacing.

TABLE XI.

YIELDS. SPACING EXPERIMENT, Z1-9.

Treatment.	*Yields (Lbs. per Acre).*	$\frac{\bar{d}}{\epsilon_d}$	*P.*	*Odds.*
6 inches	513	Not taken	—	—
12 „	444	2·03	0·042	23 : 1
18 „ (standard)	508	—	—	—
24 „	460	1·80	0·072	13 : 1

WEEKLY YIELDS AS PERCENTAGE OF TOTAL YIELD.

Treatment.	*April* 7.	*April* 14.	*April* 23.	*April* 30.	*May* 5.	*May* 13.	*May* 27.
6 inches ..	11·4	18·9	19·5	26·6	18·6	3·7	1·3
12 „ ..	8·5	18·1	18·5	22·4	19·1	6·5	6·9
18 „ ..	5·6	13·9	18·9	21·2	23·6	7·6	9·2
24 „ ..	3·9	12·7	20·7	20·0	21·9	11·3	9·5

The curves per plant per day show mainly that shedding was heaviest in the order of spacing, 6 inches to 24 inches, and according to expectation on the basis of the soil moisture content as this became increasingly low. The early shedding, however, occurred during a period when moisture was probably too plentiful. The sharp rise between February 1 and 4 is common to each curve. The soil had been saturated within the previous ten days from nearly 5 inches of rain, and the general shedding which followed was attributed to the effect of waterlogging. At the end of February the fruit on the

plants at 6 inches was almost entirely confined to bolls which had set early, though occasional flowers opened in these plots thereafter. Shedding records were discontinued on February 19, as the shedding material was too heavy to cope with. At this time only well-advanced bolls seemed likely to ripen off in any of the plots. It was noteworthy that the fruit on monopodial branches in the wider spacings seemed to be retained to better advantage, and it was seen that these contributed largely to the crop reaped. The shedding behaviour in relation to the crop is well brought out in the curves per unit area.

Flowering Records.—Twenty plants were marked in each plot of the 6-, 12-, and 24-inch treatments, and twenty plants in one plot of the standard in each of the four strips; the flower counts were taken on these, being eighty plants per spacing. Flowering records were made daily from January 14, a few days after the first few flowers appeared, to February 28. The data are given in Fig. III. as flowers per plant per day and per unit area per day, both computed as five-days averages.

The flowers per plant curves serve well as comparisons of the bearing surfaces of the plants as spaced. The low, rather flat curve for the 6-inch treatment is partly due to the heavier early shedding in these plots. Flowering fell off sharply towards the end of February, and during March everything shed except well-formed bolls. The curves of flowers per unit area per day serve to show the relative earliness of the crop brought about in the spacing treatments. This was, of course, modified by shedding behaviour, and the actual earliness is shown in the percentages of crop picked at weekly intervals (Table XI.).

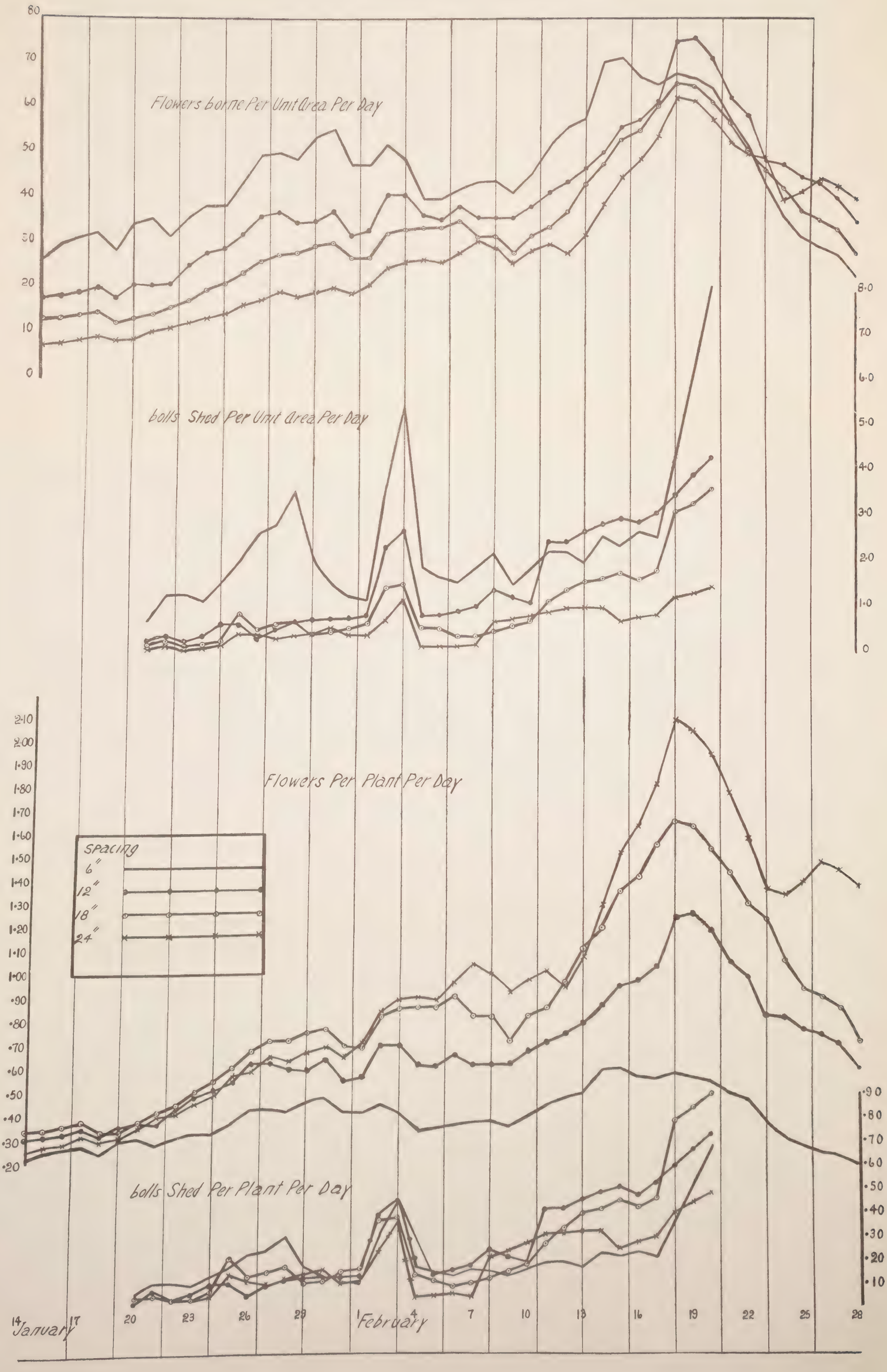
The whole experiment was cut short by the unprecedentedly dry February and March. The Z cottons make larger growth on the whole than other cottons previously grown. Pending the results of future tests, these are being spaced about 24 inches apart in commercial crops.

Boll Lint and Seed Characters.—Forty bolls, free from damage and irregularities, were taken in each spacing every week as samples for examination of various characters. The bolls selected were always four-locked, as these greatly preponderate in Z1-9 cotton; this may have introduced errors, as spacing interval may influence loculus number. Samples were taken first on March 2 and at weekly intervals to April 13.

In a spacing experiment referred to above it was found that the lint length varied appreciably with the spacing treatment, and this was remarked in the grading of commercial samples. The season in that experiment had been one of short rains with long, dry spells.

FIGURE III

SPACING EXPERIMENT



In the present case lint length has not varied beyond the limits of errors in measurements. There was a general reduction in length in the last two pickings, which may be associated with moisture shortage in February.

Boll weight in the 6- and 12-inch samples showed some reduction during the last four records. There was a graded reduction for all spacings in these samples. These bolls would be developed under increasing moisture shortage.

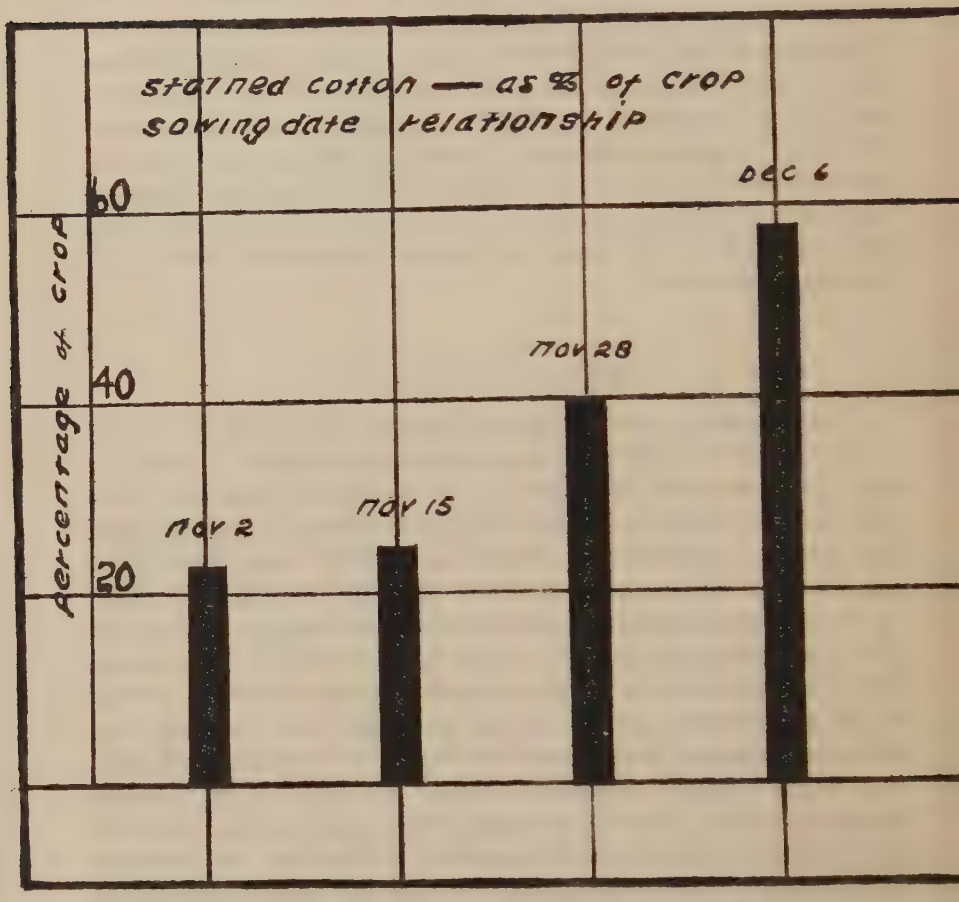
Seed weight and weight of lint per seed were regularly less in material from the plants of 6-inch spacing than from the others. The difference was very small, however, until the last two samples were reached, and these contained a high proportion of non-viable light seed, due to interrupted metabolism and premature splitting of the boll owing to moisture shortage. Seeds per boll were fairly constant throughout, such variation as there was being common to all spacing treatments in different samples. On the whole the variations found were traceable to the onset of moisture difficulties, which were peculiar for the season.

PESTS AND DISEASES.

INSECT PESTS: *Cotton Stainers* (*Dysdercus Spp.*).—It was stated in two previous Reports that *Dysdercus* did not appear in cotton in any abundance until mid-March. In the present year they first arrived in considerable numbers during the first two weeks of April. The seasonal conditions in 1925-26 and 1926-27 were much alike, but March of the present year was rainless, and the dry, hot weather no doubt retarded migration of stainers into the cotton. Malvaceous plants are abundant in shady areas on the banks of watercourses and elsewhere, and as a result of plentiful rain in the earlier portion of the season these grew in greater profusion than has been seen during past seasons. It is inferred from the work of Ballard and Evans,[1] and others, that the migratory impulse was inhibited by the arid conditions joined with the presence of food materials on *Abutilon* and *Hibiscus* species in moist locations. Ballard, *loc. cit.*, Cowland and Ruttledge,[2] and others, point out that the bugs do not appear to be specially attracted to cotton. It is well known that other plants, chiefly of the Malvaceæ, serve as additional food plants, and *Abutilon* is stated to be preferred in Queensland. *Abutilon soneratianum*, L., *Abutilon indicum*, L., and other unidentified species of *Abutilon* are particularly abundant here; species of *Sida*, *Hibiscus*, and *Cienfugosia* are commonly seen, and it may be, as others have

found, that these alternative food plants during their fruiting periods retain the attention of the stainers. The fact remains that cotton here has been comparatively free from the presence of the stainer until March or later during the past three seasons. During the season under review large, contiguous fields of ratoon cotton fruited early in the late summer without being invaded by the stainer.

FIGURE IV



Data are given in the chart, Fig. IV., and Table XII. for percentages of stained cotton taken from figures accumulated in a time-of-planting experiment laid down mainly with a view to testing the apparent relationship between sowing date and the incidence of the stainer and boll disease. The chart shows the exposure to stainer damage suffered by crops, the later the planting date in this season.

The bolls on December-planted cotton in a time of planting experiment, 1926-27, did not open owing to internal boll disease. Early planting does not necessarily mean planting earlier than October, but it would seem advisable to be prepared to take full advantage of October rains. The observations made on the plots have been borne out by the low percentage of staining in early plant cotton crops and analyses of the grading returns of commercial cotton for the past two years, as the ginning and marketing of cotton has proceeded during the reaping period.

TABLE XII.

SOWING DATES IN RELATION TO STAINED COTTON.

Sowing Date.	*Reaping Dates.*	*Percentage of Crop Reaped.*	*Percentage of Cotton Stained.*	*Sowing Date.*	*Reaping Dates.*	*Percentage of Crop Reaped.*	*Percentage of Cotton Stained.*
November 2	March 27	29·13	11·0	November 28	March 27	Nil	—
	April 4	17·65	12·0		April 4	17·3	10·5
	„ 10	11·0	26·0		„ 10	17·0	31·5
	„ 17	16·17	29·0		„ 17	31·76	39·0
	„ 24	10·65	43·0		„ 24	13·44	59·0
	May 8	15·40	61·0		May 8	20·50	68·0
		100·0				100·0	
November 15	March 27	22·7	13·0	December 6	March 27	Nil	—
	April 4	25·7	10·5		April 4	Nil	—
	„ 10	10·6	23·5		„ 10	15·0	43·0
	„ 17	20·5	24·0		„ 17	21·0	41·0
	„ 24	12·5	36·0		„ 24	25·0	50·0
	May 8	8·0	60·5		May 8	39·0	79·0
		100·0				100·0	

January sowing did not produce opened bolls.
November 2 sowing retarded by cold weather.

Very light spotted material was excluded. The longer exposure of first developing bolls in the November 28 and December 6 plots gives rise to the heavier percentage of stained cotton in these, as compared with the percentage in November 2 and November 15 plots at corresponding reaping dates.

Cotton-Leaf Beetle: Syagrus rugifrons, Baly.—The beetle winters over as the adult. The presence of large blocks of ratoon cotton in fresh leaf provided an unusually early food supply, and the beetle was found to multiply to greater numbers than have been seen for years. The infestation was more widespread than usual and the damage severe.

It was demonstrated here (cf. *Empire Cotton Growing Review*, vol. v., No. 1) that one application of calcium arsenate dust at the rate of 5 lbs. per acre destroyed 90 per cent. of the beetles infesting seedling cotton. If the growers had the necessary equipment to deal with large areas, it would require a much heavier and probably repeated application of the insecticide to dust large plants, particularly matted ratoon plants; even so it is doubtful if the mortality would be as high. There is also the danger of livestock becoming poisoned by eating the foliage of dusted plants; few cotton lands are fenced, and the cattle are accustomed to pasture on the standover cotton in the early spring (see discussion on bollworm trapping measures below).

The situation in regard to the value of calcium arsenate remains unchanged where seedling cotton is concerned, but in addition the value of placing a " beetle land " out of cotton has been given a first trial. Two fields, notorious for beetle depredations in the past, were allowed to lie fallow, 1926-27, and were planted to cotton again last season. The result was rather hopeful, as no beetles were found, although, as stated, the infestation generally was more severe. Growers are now inclined to fallow land or to alternate crops, so that the general value of these practices as means of reducing the pest should be clear in another two to three seasons.

Bollworm.—During the month of December the American bollworm, *Chloridea* (*Heliothis*) *obsoleta*, Fabr., was responsible for considerable bud loss on some lands, but it was not important thereafter.

The spiny bollworms were few in number during the entire season, and they were not abundant on their numerous wild host plants.

The red or Sudan bollworm, *Diparopsis castanea*, Hamps., commenced activity in August, and was freely found during the next three months on ratoon or standover cotton which had not been pastured by cattle. It was unusually light during the remainder of the season throughout Northern Zululand and, by report, elsewhere in South Africa. The major portion of the crop was of the ratoon character, and the first flushes on this were designedly eaten off by cattle mainly with a view to destroying the early bollworm. Certain unpastured fields were under observation, and bollworm was seen to be moderately heavy in these during October, November, and December, but not later in the year, at least until March, when a general increase in the infestation, severe in some parts, was observed. This increase in bollworm about March has occurred in each of the past three years, and has come to be regarded as the usual behaviour of the pest here.

The ratoon crop was set before the advent of the March bollworm. Plant cotton did not suffer heavily, as this was beginning to open when the bollworm increased in March and April.

LIGHT TRAPPING EXPERIMENTS.

King[3] has reported some success in catching the moths of the Sudan bollworm at a naked acetylene flare set above a shallow basin of water. A previous report by King[4] that the moths came to light was of interest, as it appeared from common report that light trapping of this moth had been tried in South Africa without success. Some experiments on the value of light traps were commenced at Candover in November of 1927, at a time when experience showed the moths to be abundant.

Initial trials, using petrol vapour and paraffin lamps as sources of light, gave nightly catches of thirty to thirty-seven moths per light, and in view of the numbers caught it was considered desirable to extend the experiments.

Ordinary inexpensive hurricane lanterns were found to give results equal to those of powerful petrol vapour lamps, although the tests were not prolonged or extensive; on the other hand, under the same conditions, a naked acetylene flame gave very low catches. In the experiments to be discussed paraffin hurricane lanterns were used, as they are cheap, effective, and easily procurable.

The lanterns were set out in circular tin basins 18 inches in diameter. The basins were filled with water to within approximately 2 inches of the brim. The lantern was placed centrally in the basin, resting on a support adjusted so that the water half covered the oil reservoir of the lantern.

Permanent Light Traps.—Seven lanterns were set out in a field of commercial cotton bounding one long side of the Experiment Station. These were established on earthen mounds at such a height that the light was clearly visible just above the cotton plants. These lights were spaced 100 paces apart. Although in general the catches would serve to indicate the value of the light traps in reducing bollworm, these traps were mainly intended to show, from the figures secured, the moth flight curve for the season. The lights were maintained in service from November 28 to April 15, being lighted each night, with the exception of some week-end nights later in the year. The row of lights was placed deeper into the field midway through the season in order to bring into range sloping ground beyond. The question of exhausting the moth supply in the neighbourhood of the old sites also had to be considered, as nothing is known of the distance these moths will travel to light.

Sudan Bollworm Moth Captures at "Permanent" Light Traps.—Total captures, November 28 to April 15, 1,764; captures, November 28 to December 31 (33 nights), 1,389; captures, December 13 to December 31 (19 nights), 1,125.

The total catch is not impressive, but it is seen on dividing the bulk of the catch into the periods which contributed it that the light traps were effective when the moth flight was large. Reference to the chart in Fig. V. shows that a moonlight period intervened to weaken or nullify the attraction of the light between the November and December catches. Single trap catches of thirty-two per night were being taken during the initial trials on the Station, and it would seem from this and the data from the above traps that these were established too late to catch much larger numbers indicative of the heaviest flight of the season. Allowing for an extension of the curve (in Fig. V.) back into September, this curve substantially illustrates the seasonal distribution of bollworm as it was found to occur in the plots. It does not agree with conditions found in commercial crops in the area in one important respect—namely, the bollworm infestation in commercial cotton was heavy in late March. A definite but slight increase, only, was noticeable in the plots and crops on the Experiment Station. This difference and a lighter infestation on the Experiment Station in the months of January and February are ascribed to the destruction of the early bollworm in carefully controlled trap crops, and to the capture of moths at lights in the plots.

It is clear from Fig. V., as expected, that moonlight periods render the lights practically inoperative as traps, if the sky is not overcast. In the usually rainy months of the spring it frequently happens that the moonlight is partially or totally obscured, and this point must be considered in evaluating light traps.

Notes were taken for a period each night on wind and darkness. On windy nights low catches were made; very dark, still nights gave the best returns.

It was seen that male moths greatly preponderated in the catches. Records of the sexes were taken for the whole period, November 28 to April 15. The results were: male moths, 85·02 per cent.; female moths, 14·98 per cent. The relative proportions of these during each month were as follows:

Month.	*Males (Per Cent.).*	*Females (Per Cent.).*
November	85·7	14·3
December	90·6	9·4
January	85·9	14·1
February	65·8	34·2
March and April	72·0	28·0

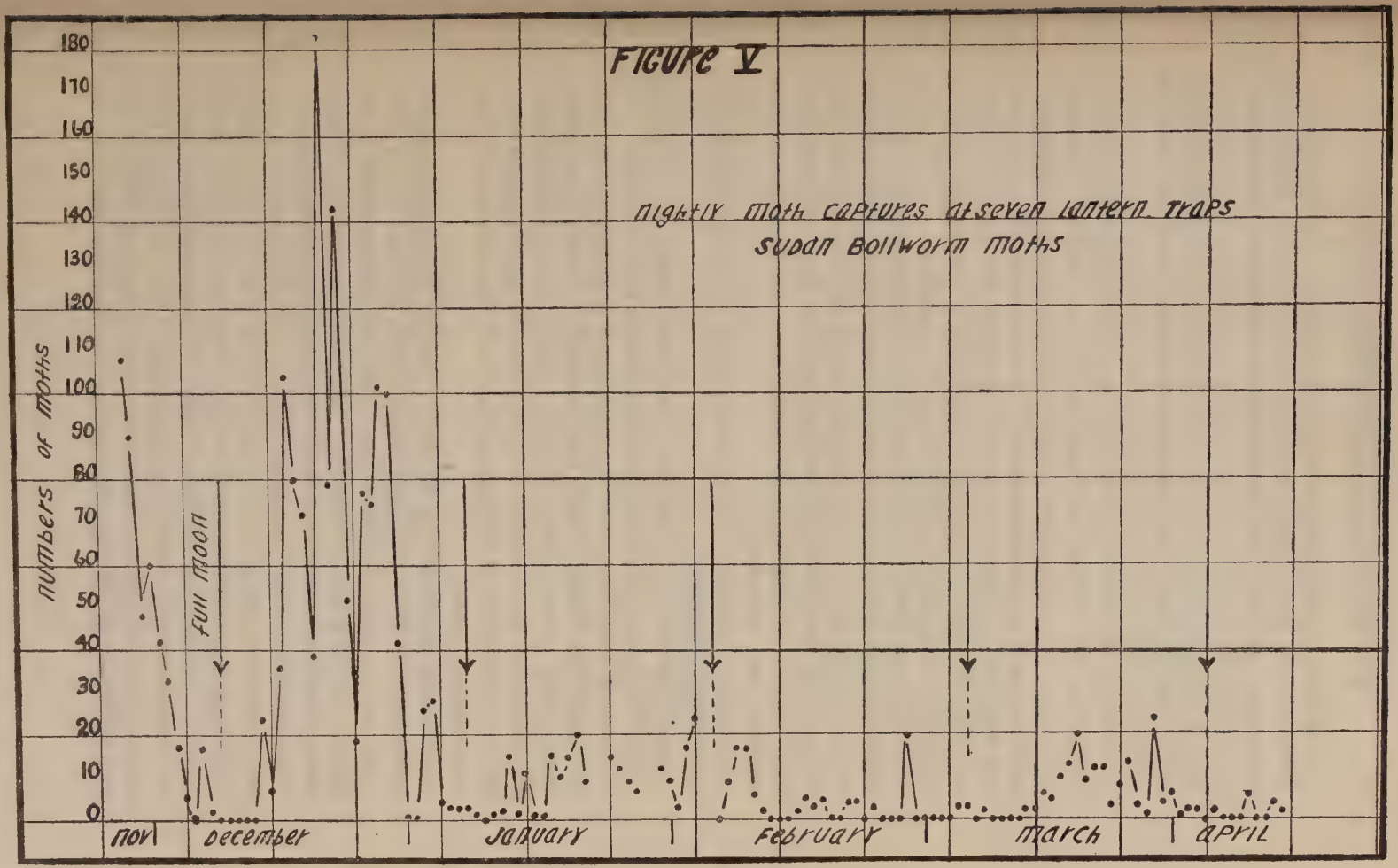


FIGURE V
Nightly Moth captures at seven lantern traps
Sudan Bollworm Moths
NUMBERS OF MOTHS
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
FULL MOON
NOV
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL

The sexes of 104 moths emerging in field cages from October to January were: males, 68·1 per cent.; females, 31·9 per cent. These proportions were fairly well maintained over the period of emergence. The figures suggest that there may be a disparity in the sexes in Nature, in which case the value of the traps is increased on the basis of the relatively few females captured at lights. The females caught were heavy with eggs, with few exceptions.

Much smaller forms of the moth were commonly found in the receptacles: 351 moths were collected over a week in December, and of these 140, or 40 per cent., were found to be rather more than one-half the size of the ordinary moth. They differed only in size, and may have resulted from some check in larval development; it was clear that the egg capacity of the small females was greatly reduced. The large and small forms were observed to copulate.

Other Insects coming to the Traps.—A few male moths of *Chloridea obsoleta* were caught in traps set out by a neighbouring cotton-grower. Well-developed larvæ were moderately abundant, but egg-laying was not, and as local attacks of this bollworm in the past have been sporadic, it is probable that the moths were not in evidence when the lights were operating.

Spiny bollworm moths were rarely found, but this insect was not active during the season.

Large numbers of *Cosmophila auragoides*, Guen, were trapped during December. This is an important minor pest of cotton.

Coloured Light Traps.—It was considered important to try light other than white light. Lights were arranged giving red, blue, green, orange, and violet coloured light, through glass. Unfortunately these could not be given a fair trial, as, when the apparatus was available, the moth numbers had become very low. The data recorded are too meagre to report.

The Range and Position of the Light—Lighting Periods—Accessories to the Light.—Experiments were carried out on these problems. Progress was not made with the first. The experiments could not be commenced until late in December, and, as the diagram in Fig. V. shows, thereafter moths were too few to give substantial returns.

Observations on the permanent series of lights showed few, if any, captures of the Sudan moth before 9 to 10 p.m. In the lighting periods test the night was divided into three periods, using four lamps for each. Moths were not taken before 10 p.m., and consequently oil consumption may be accordingly reduced if this is confirmed next season; other reductions towards dawn seem likely, and this is desirable, as the cost of oil is the largest item of recurrent expense. The

cost, when using the paraffin lanterns throughout the night, for oil alone was approximately 2¼d. per lamp, which is very low.

Larger captures were not recorded if the diameter of the receptacle was increased beyond 18 inches. On the other hand, by placing wire-gauze leads, 12 inches in depth, running out from the lantern across the water receptacle, increased catches were recorded on the windward side of the gauze. Further adaptations of this nature will increase the efficiency of the trap.

SUDAN BOLLWORM MOTH EMERGENCE IN FIELD CAGES.

Bollworms were collected in bolls on the plants during February, March, April, and May of 1927. These were allowed to pupate in boxes containing the ordinary soil from the Station plots. The pupæ were accumulated and placed 2 to 4 inches deep in the soil under coarse wire-gauze cages in the open field. The cages are 3 feet square on the sides and 3 feet high off the soil surface. The pupæ were exposed to natural conditions, with the exception of some slight shade effect and reduction in wind force, produced by the wire-gauze (mosquito-netting mesh).

These cages were referred to in the last Report, the object, as described, being to collect data on the times and numbers of moth emergences in relation to cotton trap crops: 348 pupæ were placed in the cages. These were representative of the bollworm which pupated in the cotton lands during the above months, and the whole period covered the latter half of the cotton season. The emergence data are given in the following table :

TABLE XIII.

MOTH EMERGENCE IN FIELD CAGES.

PUPATIONS FROM FEBRUARY, MARCH, APRIL, AND MAY BOLLWORM, 1927.

Number of pupæ inserted = 348.

Emergence in Month of	*Number of Moths Emerged.*	*As Percentage of Total Emergence.*	*Percentage of Moths Emerged to Pupæ Inserted.*
April and May, 1927	8	11·94	19·3
October, 1927 ..	16	23·88	Emergence to November 30 is 61·19 per cent. of total.
November	17	25·37	
December	21	31·34	Emergence to December 30 is 92·53 per cent. of total.
January, 1928 ..	5	7·46	

No moths have emerged since January, 1928.

The percentage of moth emergence to pupæ inserted is taken to be good under over-wintering conditions, although no figures for comparison are available. The remaining pupæ have not been disturbed for examination as yet. It is still possible that moths will emerge, as very long pupation periods are known, although exceptional.

The point of chief interest in these figures is that 92·53 per cent. of the total emergence occurred by December 31, 1927. This information adds material support to the field observations on the value of trap crops to be discussed below.

Cages were designed to hold the pupæ from larvæ, which it was proposed to collect month to month, with a view to learning something of the moth emergence behaviour during the season. Material was secured for September, October, and November, but thereafter, until April, sufficient numbers could not be obtained with the time at our disposal and the paucity of material.

Sixty-four pupæ were inserted in a combined September and October cage. Twenty-five moths emerged by January 31, the percentage of moths to pupæ being 39 per cent. The emergence at December 31 was 68 per cent. of the total. These bollworms had been collected off standover cotton which had not been pastured down by cattle. Two moths have emerged since January. The figures are of interest, as most of the emergence occurred during the period in which trap crops are considered to be effective and before plant cotton is well advanced in fruiting.

Very few pupæ were obtained from November larvæ, and these few were destroyed within the cage by some insect. Parasitism was suggested in both cases, and was evidently very extensive, as the collections of larvæ were unusually large.

Parasites.

Sudan Bollworm.—An egg parasite was reared at Candover during the season from Sudan bollworm eggs collected on abandoned cotton in the Lebombo Flats area. This has been identified by the Imperial Bureau of Entomology as *Trichogramma lutea*, Girault. This does not appear to have been reported heretofore from South Africa. It is not included in a recent list of bollworm parasites and predators in South Africa,[5] although this list includes a Trichogrammid and an Encyrtid, stated to be new species. Beyond the presence of the parasite little is known except that it has not as yet been bred from eggs taken in the immediate Magut area.

Lonchœa aurea. Macq.—Bolls bearing a frothy, spittle-like mass on the exterior were commonly seen in January and February. The

mass was always formed over a bollworm aperture, and in the majority of cases a flaccid, dead bollworm was found under the mass at the edge of the aperture. Flies, *Lonchæa aurea*, Macq., were bred out from bolls bearing the frothy matter. This is reported to be a very widely distributed species (Imp. Bur. Ent.): "It appears to be almost entirely a fruit frequenting insect and is probably attracted by fermenting juices." It seems highly probable that the fly is attracted by the fermentations set up by bollworm feeding. From the cotton-grower's point of view the boll is lost in any case, as the damage by the froth, which grows sticky, is added to the bollworm damage, but the fly may be regarded as an agent in the natural control of the bollworm.

BOLLWORM TRAP CROPS.

The trap crops on the Experiment Station represented one-tenth of the area under cotton. There were three blocks, 1 acre each—one situated towards each end of the area and one centrally situated. Various experiments with cotton and seed multiplication blocks were advantageously situated in relation to the traps for the purpose of observing bollworm conditions. Large fields of commercial cotton at a distance of a mile to two miles from the Experiment Station served for comparison as to the amount of infestation in plant cotton. One long side and end of the Experiment Station is bounded by wooded pasture. The other long side and end is bounded by cotton fields, which were in ratoon cotton during the season. These fields were pastured off by cattle in the spring months and light traps operated inside the fields later. It was considered in view of this that the bollworm arising in the plots and crops on the Station would be mainly our own breed.

One-half of each trap block was left over winter as standover cotton, the other half was ratooned back to 10 inches above ground, leaving short lengths of lateral branches with two to three leaf nodes. The pruning was done in late June. A July rain brought on fresh leaf growth. The standover cotton was flowering in August and the ratoon cotton was bearing buds.

Method of Cutting Back Trap Crops.—Cane knives were used. It was not desired to cut the plants back as in ratooning, but rather to ensure that fruit containing larvæ and the most of the eggs, which are placed about the bracteoles, pedicels of buds and young leaves, should be taken off. This object was considered to be satisfactorily accomplished by whipping off the laterals about midway from the main stem, and in the first treatment of the standover cotton to top each plant severely. Numbers of small buds were left.

It was found by experiment that half-grown larvæ could attain full growth if restricted to a small boll each. Such bolls containing half-grown larvæ were placed on the soil in the open, and cases of pupation were observed a fortnight later. In view of this, bolls carried over the winter on trap crops should be removed before August.

Treatment of Trap Crops.—The traps were cut four times. The dates of cutting and infestations at these times were as follows:

Date of Cutting.	*Trap (Standover Area or Ratoon).*	*Infestation.*	*Plant Condition.*
October 5 ..	Standover cotton (Standover only cut)	Moderately heavy, larvæ well grown	Flowering freely.
	Ratoon cotton	Very light, mainly eggs	Budding freely.
October 25 ..	Standover cotton (both cut)	Light, small larvæ in buds	Rapid new growth-budding.
	Ratoon cotton	Moderately heavy, advanced larvæ	Flowering freely.
November 29	Standover cotton, Ratoon cotton (both cut, now treated as one)	Heavy	Plants very leafy and squat; flowering freely.
January 3 ..	Both cut as one	Light	Very rapid recovery from November cutting; flowering.

The growth following the last cutting was very matted and squat, giving a mound-like appearance. The plants were left to make a crop, as bollworm was negligible during the remainder of the season. This could not be attributed altogether to the value of the trapping measures, as it was lighter than usual elsewhere, but we did not experience the heavier bollworm attack in March which was general in the area. Early planted cotton on the Station was budding and in some cases flowering with a minimum of bollworm in December. This was not the case in equally advanced plant cotton elsewhere. The evidence showed that the traps were affording protection to the plant cotton, and that the moths were more attracted to advanced cotton.

The yields from the trap areas may be compared with the average yield from commercial crops of Zululand hybrid and Z1. It will be recalled that February and March were rainless months.

Average yield trap areas	344	lbs.	seed	cotton	per acre.
„ „ Zululand hybrid	321	„	„	„	
„ „ Z1-bulk	411	„	„	„	

The quality of the lint from the traps was not considered to be as good, but it graded as well. The crop was reaped by the end of April, much of it being immature. The fact that trap rows may be stripped as late as January 3 and give a crop attaches more value to the method from the growers' point of view. Trap crops on a large scale have now been arranged.

CIENFUGOSIA HILDEBRANDTII, GARCKE.

It was reported in 1926 and again in 1927 that eggs and larvæ indistinguishable from those of the Sudan bollworm were found in abundance on this plant, but that the moth had not been reared from pupæ secured from the larvæ on the plant. It was considered necessary for the moth to be actually seen before the identity of the insect could be definitely known. Moths have now emerged, and are undoubtedly *Diparopsis castanea*.

The plant has now been found throughout all the cotton districts in Zululand, and is known to be abundant in Southern Swaziland. It grows in colonies, in some of which over 100 plants have been counted. The plants fruit well, carrying anything from two to twenty-five or more capsules, and although the capsules are smaller than a single lock of a cotton boll, they are frequently found to contain a full-grown larva, which, judging from the size of the place of entry, has been there during most of its growth period.

These plants are much more abundant than wild cotton or *Hibiscus calycinus*, the only other known wild host plants, and are undoubtedly a main, if not the main, source of infestation in new cotton lands remote from other cultivation.

DISEASES IN COTTON.

Anthracnose: Glomerella (*Colletotrichum*) *gossypii* (Southw.).—Anthracnose was found, but not frequently, on bolls in the previous season. During the early seedling period of the season under review spotting and marginal injury of the leaves was very prevalent in the area, and the growth of the seedlings was much retarded. The trouble was diagnosed as Anthracnose from specimens submitted to the Division of Botany, Pretoria.

Rust: Kuehneola gossypii (Lager), Arth.—A light attack of rust caused by this fungus was general on ratoon cotton plants in late February. It has not been observed before. Some cases of unusual leaf fall were reported from Zululand which were found to be due to this fungus. In one instance the plants in small patches of a field had been defoliated.

Alternaria macrospora, Zimm. (*A. longipedicellata*, Reich.).—In the Empangeni area of Zululand it was observed that numbers of plants in a field bore withered leaves or were naked, whereas the bulk of them were apparently healthy. Examination showed plants in various stages of a leaf disease apparently caused by a leaf-spotting fungus. Specimens sent to the Imperial Bureau of Mycology were reported to be infected by *Alternaria macrospora*. This was a localized attack, and certain conditions appeared to be present which rendered the foliage abnormally susceptible to infection, as the fungus was able to enlarge the spots rapidly and sporulate freely. Pronounced dry weather followed a wet period, and it is probable that this was associated with the incidence of the disease, as the dry conditions set in abruptly.

Internal Boll Disease.—This is dealt with under *Dysdercus* spp.

Other Crops.

Sorghums.—Nine South African-grown sorghums were set out in observation plots. Seed for five of these, including a saccharine type, was procured from the Department of Agriculture, and was derived from improved strains of white and red grain sorghums. Seed from strains previously grown on the Experiment Station was taken from bagged heads and some single-plant selections. The parent material for these latter consisted of two dwarf varieties with growth periods of 100 to 120 days, and two strains with long growth periods. These were procured two years ago from the Dry Land Station, Pietersburg, Transvaal.

Ten variations of Indian-grown sorghums, introduced at Barberton last year, were set out in observation plots.

On the whole the sorghums suffered severely from aphids and rust, and in our case the stalk-borer, *Busseola fusca*, Fuller, destroyed practically everything in the early sown plots. These were ratooned, leaving one or more suckers, for experimental and seed purposes. As the borer again became evident, all plants were given treatment with Ripley's Kerol formula (1 in 350 water). This enabled us to defeat the borer to a large extent, but the ratoons were unable to ripen seed owing to the drought late in the season.

None of the Indian sorghums showed promise at Magut, and all failed to ripen seed, although left until late June. One variety, Red Coimbatore, succumbed to rust.

The early maturing dwarf types were everywhere the best for the season. The relatively long growing season in the low veldt area permits a crop of these to be fitted in early and/or late, if conditions

are good enough. A number of these types are being collected. The work on sorghums is being extended, and the possession of more land will further this work immediately. Data are needed on the seasonal behaviour of the stalk-borer here, and on sowing periods for early and late maturing sorghums. All seed should be treated with formalin against smut.

Groundnuts.—Thirty varieties of groundnuts were grown. These represented a good range of erect and procumbent forms, and differing nut characteristics.

The plots were sown at a date which exposed them during pegging to the very unusually dry period in February and March of this season. It also so happened that rodents were sufficiently abundant to make serious reduction in the crop borne by all the upright varieties, although procumbent varieties were unattacked. Yields were unduly low in consequence.

Growth from germination to flowering was moderately good on the earlier lots, and there is little doubt that commercial crops would have been profitable, had there been no sharp break in the late rains, as the plants were practically free from pest and diseases. Rosette was observed in a very few cases.

Work is proceeding on cultural and harvesting methods, and growth trials will be extended as far as seed supplies permit. Attention is directed to sowing dates. The bulk of the crop is produced in the Transvaal, where the season commences appreciably later, so that it frequently happens that earlier crops here command higher prices.

On account of the difficult ripening-off conditions, analyses for oil content, etc., were not made this season.

A large-seeded Virginia Bunch type has now been multiplied, so that a wider distribution to farmers is possible, and this seed is in considerable demand. Through the courtesy of the Bureau of Plant Industry, Washington, U.S.A., a small lot of seed from *Arachis nambyquarœ* has been procured. This is unusually large-seeded, and is unlike other groundnuts in that the testa is partly reddish-brown and partly whitish or bleached in appearance. This may prejudice the market against it. This species comes from Brazil.

Bambara Groundnut: Voandzia subterranea.—This is known on local markets as the jugo bean, and it is commonly in good demand. Observation rows showed it to be attacked by the jassid, *Empoasca fascialis*, and the crop is difficult to harvest owing to the slender peduncles breaking when the plants are lifted, with the result that most of the nuts are left in the soil. The crop appears to be suitable for small-scale planting, and has been profitable as such. The plant,

and harvesting methods, are susceptible of improvement, and work with this crop should be continued.

Soya Beans.—Eight varieties were grown. These were sown in mid-December, and in consequence suffered from lack of moisture during pod-setting of the later varieties. The heavier cropping (this season the earliest) varieties yielded moderately well; these were American Eyebrow, Chinese White, and Brownie. Three of the lots are more suitable for fodder, although they could not compare in that respect with cowpeas, which were in growth at the same time. A minor leaf-spot disease was observed. The plots were free from insect pests. Formal yield trials of several of the lots will be made, and it is intended that the crop should be grown on a field scale.

Tobacco.—It was considered that simple demonstration plots of a number of well-known varieties of tobacco would be helpful to the farming community, as interest was being displayed here in tobacco-growing under dry farming conditions. Ten varieties of Virginia and seven varieties of Turkish tobacco were grown.

The plots were of interest and value to farmers, who inspected them, accompanied by Tobacco Officers under the Department of Agriculture. The difficulty of marketing tobacco at the present time will restrict tobacco-growing, but the plots have drawn attention to the probable suitability of our conditions for Turkish tobacco and the characteristics of certain of the Virginia types, notably White Burley.

General.—Among a number of crops grown for sale as apart from soil improvement, sunflowers and tepary beans should be mentioned. The overseas market is sufficiently attractive for sunflower seed to bring this crop into a cropping scheme, and high yields are not uncommon. The tepary bean is, so far, the outstanding bean grown here, being prolific, hardy, and drought-evading through earliness. It does not command as high a price as other beans, and attention is directed to a wide range of others, which were cut short by dry weather this season.

The Iron cowpea is the only one grown on the Experiment Station. This gives an excellent smother for weeds and yield of hay, but the grain return is negligible owing to pod weevils.

Buckwheat has proved to be a desirable green manure and cover crop. The practice on the Experiment Station is to allow the buckwheat to ripen a first crop, harvesting sufficient seed for needs, and ploughing in later the growth which results from the germination of shattered seed.

Multiple cropping schemes embracing maize, groundnuts, and

beans were unsuccessful this season owing to the washing out of the stand during heavy rains. Trials of sunn hemp, niger, and sesamum were a failure for the same reason.

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REPORT ON THE WORK AT THE INGWAVUMA SUB-STATION, SWAZILAND

BY

F. S. PARSONS.

Introductory.

The Sub-Station, which was commenced in September, 1927, comprises 25 acres on the Farm Lismore, the property of Mr. J. D. Inglis, and is under his charge. The farm is situated in Southern Swaziland between the Ingwavuma River and Gollel, a railway terminus on the Swaziland-Transvaal Border.

The railway was completed last year. Railway motor services now link up the terminus with other parts of the Territory over a main road, which is being put in excellent condition. These services naturally greatly improve the situation for estates and settlers in this area. The Farm Lismore is thirteen miles from the terminus, and the main road passes along its frontage, so that the Sub-Station is readily accessible.

In this neighbourhood one large estate and a few farmers are engaged in cotton-growing among other activities. Much of the unoccupied land is privately owned, and no doubt the improvements in communications and other facilities will mean that more land will be brought into cultivation.

Climatic Conditions.

The effective rainfall during the season was 16·7 inches. This includes an early September fall of 0·75 inch, which was of value for soil preparation. The total does not include a late July rain of over 2 inches, as this contributed no residue of moisture for the coming season. It was of value, however, for winter ploughing. Such mid-winter rains are not uncommon, and where fallowing is conducted, add very materially to the moisture conserved.

The distribution of the rain, October to early February, was sufficiently good to promote moderately good crops, but thereafter, to latter March, the period was rainless as in the Candover District. Cotton here did not suffer as much from the sharp, dry spell. Under

the lower rainfall and its distribution, the plants had deeper root systems, and they did not attain to succulent growth. Commercial yields were much on a par in this area and in the Candover area.

The rainfall is depicted in Fig. 1 (p. 92).

TABLE I.

TEMPERATURES (DEGREES F.) INGWAVUMA SUB-STATION.

Month.	*Mean Maximum.*	*Mean Minimum.*	*Hottest Day.*	*Coldest Day.*
October	82·0	60·2	104	51
November	85·2	61·4	101	55
December	85·7	64·0	102	58
January	87·4	70·4	101	58
February	83·0	65·7	98	57
March	88·9	65·5	100	62

This portion of the country is believed to experience higher summer temperatures than neighbouring areas at higher altitudes. It is of interest, therefore, to compare the records in Table I. with those taken at the Candover Experiment Station and given in Table II.

TABLE II.

TEMPERATURES (DEGREES F.) CANDOVER EXPERIMENT STATION.

Month.	*Mean Maximum.*	*Mean Minimum.*	*Hottest Day.*	*Coldest Day.*
October	86·7	59·7	102·5	53
November	83·9	62·7	96·0	55
December	84·1	64·4	102·5	50
January	85·5	67·1	100·0	57

It is seen that there is practically no difference in the temperatures at the two places.

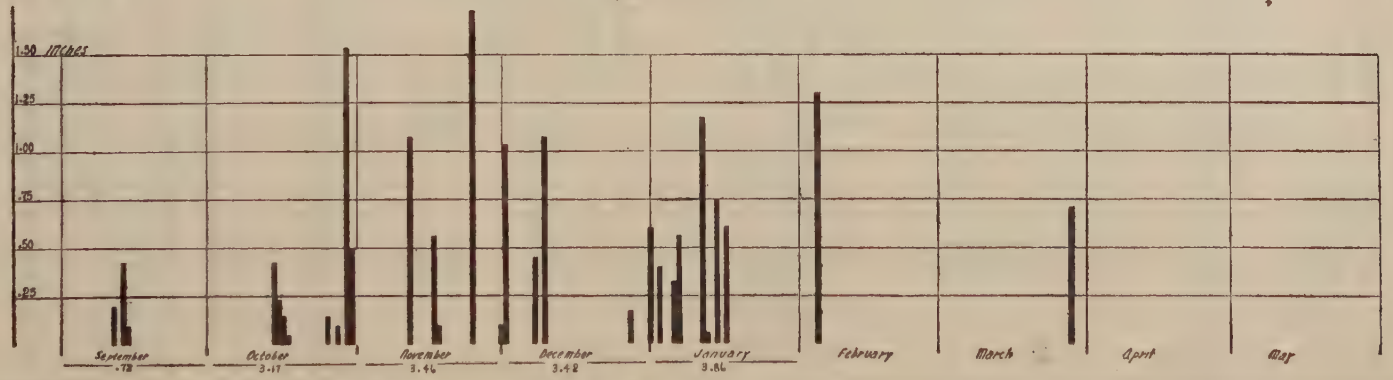
PROGRAMME OF WORK

The land selected for plots was well prepared and suitably divided in good time for planting.

The work at the Sub-Station provides for observation and multiplication plots of various strains of jassid-resistant cotton. The plots also serve for demonstration purposes. All plots during this

FIGURE I

Rainfall Chart 1927-28
Ingwavuma, Swaziland.



first season were designed for observation purposes only. These followed the experiments and tests carried out at Magut, both in cotton and alternative crops.

Multiplication Plots.

Selfed Z Strains.—The five strains referred to in the Candover Report were grown. These could not be distinguished from one another during growth and fruiting. They all grew well and were superior to the local variety in fruiting and vigour. The plots were not comparable for yield data. The superiority of the Z cotton over the ordinary mixed lots was very evident elsewhere in the neighbourhood.

U4.—This was outstanding as elsewhere, yielding nearly double the crop of any other variety. The seed from the U4 plots is being distributed for further multiplication in Swaziland by Mr. MacDonald, and there can be no doubt that high yields from it will be common.

Other Strains.—Little can be reported of these, with the exception of Z106. Under the lower rainfall here it was remarked that this strain displayed the least distress, and this affords some confirmation of observations made elsewhere.

Sowing Dates Test.

These plots were laid down for the purpose of observing any relationship between sowing date and bollworm and the incidence of internal boll disease. The sowing dates were November 12, November 21, and December 2. The percentage of the crop stained in relation to the sowing date was substantially the same as reported from Candover. The stainer was observed to enter cotton at both places about the same time this season. Bollworm is referred to later.

Edge effect was so pronounced in these plots that roots were excavated. A root is seen in Plate 1. The longest lateral is 10 feet 6 inches long, but this was broken off at a point where the diameter was still $\frac{1}{8}$ inch. Rows sown adjacent to these plots eleven days later suffered delay in growth owing to moisture difficulties, but plants in the outside rows of these later sown plots never grew more than 7 to 8 inches high, whereas inner rows attained a height of 2 feet 6 inches.

Thinning Experiment—Time of Thinning.

The plots were set out for observation purposes in conjunction with the more extensive experiment at the Candover Experiment Station.

These plots were arranged on the half-drill-strip method, allowing four comparisons with the standard. The standard was taken as 6 inches, this being the height of the plants in the standard plots when the rows were thinned to single plants at 18-inch intervals. The other heights at thinning were 4 inches, 8 inches, 10 inches, and 12 inches. The plots were $\frac{1}{40}$-acre areas.

The experiment was commenced mainly with a view to observing if the seedlings benefit when competition in the row is reduced by early thinning out, it being noteworthy that the thinning operation is commonly delayed until the plants are 8 to 12 inches high. It was found last season that early thinning during a period of difficult soil moisture conditions allowed the stand to progress very appreciably in advance of cotton thinned when the plants were 8 inches or more in height. The present test was conducted under conditions of ample moisture during the seedling period. The yield data are given in Table III. The dates on which the various thinning operations were carried out were as follows:

4-inch thinning operation	December 3.
6 „ „ „	December 5.
8 „ „ „	December 9.
10 „ „ „	December 20.
12 „ „ „	January 2.

TABLE III.

Yield Data—Time of Thinning.

Treatment.	*Yield per Acre (lbs.).*	*Yield as per Cent. of Standard.*	ϵ_d.	$\frac{\bar{d}}{\epsilon_d}$.
4-inch thinning	—	106·5	3·74	1·72
6 „ „	515	100·0	—	—
8 „ „	—	96·5	6·50	0·503
10 „ „	—	84·9	5·70	2·93
12 „ „	—	67·9	2·80	11·70

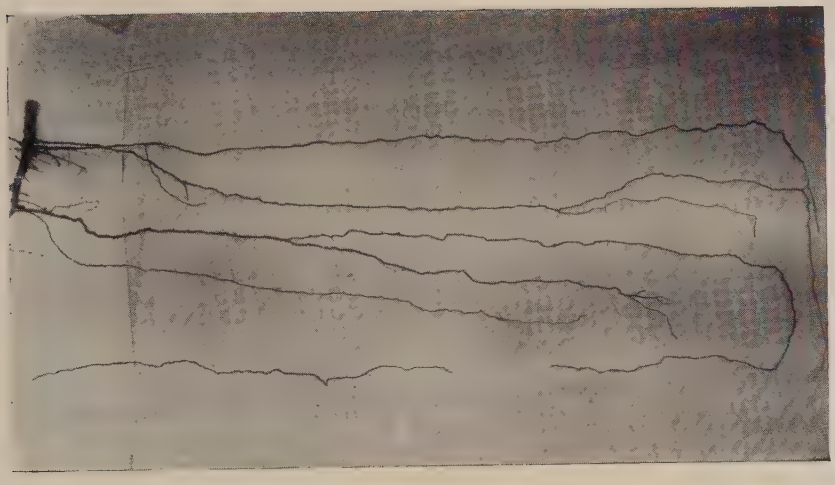


PLATE I.

TABLE IV.

Time of Thinning.

Percentage of Crop Picked at Reaping Dates.

Treatment.	*March* 12.	*March* 16.	*March* 20.	*March* 30.	*April* 11.	*May* 8.
4-inch thinning	8·23	8·83	16·81	53·20	9·90	3·03
6 „ „	6·63	7·86	16·20	56·00	9·85	3·46
8 „ „	5·60	7·90	14·10	60·30	9·05	3·05
10 „ „	5·06	6·92	14·75	57·50	12·50	3·27
12 „ „	3·33	5·85	11·10	52·70	18·40	8·62

Four- to eight-inch thinning is seen to have been beneficial this season also. The later thinned plots had an appreciably higher percentage of the crop stained owing to their later maturity.

Insect Pests.

Bollworm.—The Sudan bollworm was freely found in the months of October and November, but thereafter it was not abundant until March. A trap crop scheme covering 60 acres is laid out for treatment next season. The wild host plant of the Sudan bollworm, *Cienfugosia Hildebrandtii*, Garcke, is to be found in abundance in this area.

The spiny bollworm was present in scanty numbers.

Jassid.—Jassid occurred in sufficient numbers to test the resistance of the cotton strains and to demonstrate to growers that it is resisted in this environment.

Other Crops.

These may be referred to briefly, as the results at Lismore were much like those reported from Candover. All the alternative crops grown at Candover were tried here with the exception of tobacco and beans other than soya beans. Tobacco is well known in the district. The beans were not planted according to plan, as the February rains failed.

The dwarf sorghums were the best here also, and selections were taken again in Hegari and others. The local sorghum seed is a mixture which gives rise to various types which may repay study, and this is being grown for selection purposes. The Indian sorghums were a complete failure.

It is proposed to continue with groundnuts, sorghums, sunflowers,

soya beans, and other beans in yield trials, and to place out observation plots for a few other crops which may be profitable for small acreages.

Clean Fallow.—This was unsuccessful, as we were not prepared for the packing effect on the soil of sharp, heavy downpours of rain. In order to preserve a sufficiently deep, loose top an implement of the grubber pattern is required.

Under the present system of soil management one-half the plot area will be fallowed each year.

Improvements.

The 25-acre block has been fenced, and roads have been constructed with a high camber to check or prevent the wash of surface water following from sharp, heavy thunderstorms. A small shed for the storage of seed and tools is under construction.

SWAZILAND

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATION, BREMERSDORP, FOR THE SEASON 1927-1928

BY

D. MACDONALD.

Brief mention was made by Mr. R. C. Wood in his Report for the season 1925-26 of the undulating nature, and lack of soil uniformity, in the land used for his experimental work at Bremersdorp. For this reason it was decided not to utilize this land for future experiments, but to try to obtain a more uniform area elsewhere. With the assistance of Mr. F. S. Parsons, Cotton Officer, Zululand, a plot of land on Mr. P. J. Lewis's farm in the Matapa district was chosen for use during the season.

The land is situated six miles from Bremersdorp, at an altitude of 2,200 feet. This is probably just the upper limit for cotton-growing in this country, but as the surrounding district is the most closely settled cotton-growing area in Swaziland, it is felt that this alone justifies its position as a Cotton Experiment Station.

The soil is a medium red loam, and, apart from the fact that it tends to cake after heavy rain, has proved satisfactory.

Season and Climatic Conditions.

The past season opened most promisingly, good rains during July and the early part of September permitting most of the cotton lands to be winter ploughed. This was followed by heavy rains in the latter half of October, with the result that the bulk of the cotton crop was planted by the middle of November.

The early progress of the crop in the middle-veldt area was slow. Low temperatures accompanied by strong winds retarded growth considerably, and it was not until the advent of higher temperatures and better conditions towards the middle of December that any appreciable growth was made.

The total rainfall for the season over the greater part of the cotton area would have been sufficient for the requirements of the crop, had its distribution been more even. Unfortunately, however, its distribution was most erratic; in some parts 16 inches, or more than

half the rainfall registered during the season, fell in the first fortnight of January. Following the heavy January rains came the drought of February and March, felt most severely in the Lebombo and White Umbulusi areas, and only partially relieved by light showers in April. The Bremersdorp area did not suffer to the same extent during February and March. A good rain in the last week of March, followed by another in the early part of April, resulted in a good late crop being set. On the whole, the past season has been more satisfactory than the two previous ones, and afforded an opportunity of observing the behaviour of the new jassid-resistant strains under flood and drought conditions.

PROGRAMME.

Variety Trial.—Seed of seven jassid-resistant selections was supplied by Mr. F. R. Parnell, Cotton Breeding Station, Barberton, for use in this experiment. The strains to be tested were numbered B.143, B.179, B.180, A.12, U.4, Z.49, and Z.1-9. In the past the bulk of the cotton grown in Swaziland has been a variety known locally as Uganda, an Upland variety which is susceptible to jassid. This cotton was included in the trial both as a jassid control and for comparing the yield of the jassid-resistant selections with that of the local cotton, when grown under similar conditions. The seed used was grown under drought conditions at Barberton the previous season, and in comparison with the local Uganda variety gave a very low germination percentage. Germination tests on the seed gave the following results:

Variety.	*Germination (Per Cent.).*	*Variety.*	*Germination (Per Cent.).*
Uganda	76	A.12	58
Z.1-9	56	B.179	54
B.180	52	U.4	52
Z.49	50	B.143	45

The experiment was laid out in four adjacent blocks, in plots of four rows, 80 feet long and 3 feet 6 inches apart ($\frac{1}{10}$ acre). Each strain was repeated eight times with four rows of the strain Z.1-9, which was used as the standard, on each side of it. All the seed was delinted by sulphuric acid previous to planting, which was done by hand, in hills 1 foot apart in the rows. Planting was done on October 25 to 28, one block containing two repetitions of each strain

being planted per day. Lack of an adequate supply of labour prevented the whole experiment being planted in a shorter space of time.

Conditions at time of planting were favourable to good germination, but heavy rains on October 28 and 29 followed by dry winds caked the surface of the soil, making it difficult for the seedlings to rupture the crust formed. Replanting of blanks accompanied by hand-watering resulted in a fairly uniform stand being obtained for all the jassid-resistant strains with the exception of B.143. The stand on the B.143 plots was not so good on account of bad germination. The better germination of the Uganda seed produced a much better initial stand than any of the other strains, and the growth and development of this strain was ahead of all the others during the early part of the season.

Picking was begun on April 25 and continued at intervals of fourteen days, the yields from each row being picked and weighed separately. The total yields are shown in Table I.:

TABLE I.

Variety.	*First Pick (lbs. per acre).*	*Second Pick (lbs. per acre).*	*Third Pick (lbs. per acre).*	*Fourth Pick (lbs. per acre).*	*Total Yield (lbs. per acre).*
U.4	570·0	266·5	173·5	45·5	1,055·5
A.12	291·5	176·5	196·0	63·0	727·0
Z.1-9	211·0	178·0	182·0	64·0	635·0
B.143	140·0	159·0	171·0	78·5	548·5
Uganda	325·5	123·0	75·5	20·0	544·0
B.179	164·5	128·5	128·5	60·0	481·5
Z.49	110·0	117·5	157·5	62·5	447·5
B.180	162·5	110·5	113·0	35·5	421·5

In examining the results the yields of two-row totals of each variety were compared with the yields of two rows of the adjacent standard Z.1-9, thus giving sixteen comparisons with the standard for each variety. The results are summarized in Table II., the varieties being placed in the order of merit.

The difference in yield between each of these varieties and Z.1-9 is highly significant. In each case the mean difference as compared with the standard error is such, that the odds are more than a hundred to one against such a result arising by chance. Two varieties, U.4 and A.12, have both shown an increased yield over the standard, while the other five show a decrease on the standard.

TABLE II.

Variety.	*Yield per Acre (lbs.).*	*Mean Yield per Half Strip.*	*Mean Difference from Adjacent Standard Z.1-9 (ozs.).*	*Standard Error (E) of Mean Difference.*	*Mean Difference (E).*
U.4 ..	1,055·5	211·1	+85·1	8·49	10·02
A.12 ..	727·0	145·6	+24·7	5·6	4·4
Z.1-9 ..	635·0	127·0	—	—	—
B.143 ..	548·5	109·7	−28·7	8·88	3·12
Uganda ..	544·0	108·8	−20·3	5·83	3·50
B.179 ..	481·5	96·3	−40·8	7·15	5·70
Z.49 ..	447·5	89·5	−34·3	6·10	5·70
B.180 ..	421·5	84·3	−48·3	8·55	5·70

The comparison of the difference in yields between U.4 and A.12 is given in Table III.:

TABLE III.

Variety.	*Mean of Single Row (ozs.).*	*Variance of Mean of Thirty-Two Rows.*	*Mean Difference.*	*Standard Error (E) of Mean Difference.*	*Mean Difference (E).*
U.4.. ..	105·5	25·24	+32·7	6·54	5·01
A.12 ..	72·8	17·57			

The mean yield per single row of the U.4 taken from all the eight plots, compared with the mean yield per row of A.12, gives a difference of +32·7 in favour of the former. This difference has a standard error of 6·5, so that it is five times as large as its standard error, and is highly significant, the probability that it is due to chance being less than one in a hundred. The results show that although three of the strains tested, B.179, B.180, Z.49, gave a decreased yield compared with Uganda, three of the strains, Z.1-9, A.12, and U.4, represent definite successive improvements in yield on Uganda, each being successively better than the one before, in the order named.

An examination of the yield figures at successive pickings shows that U.4 and A.12, in addition to producing the biggest yields, are much earlier than the other jassid-resistant strains. The importance of being able to grow a jassid-resistant strain which, in addition to being a heavy cropper, is also an early maturing cotton, cannot be underestimated in a country where a great proportion of the cotton reaped late in the season suffers considerable damage from stainer.

That the local Uganda produced 82 per cent. of its crop in the first two pickings is due to the fact that jassid attack prevented all but the early formed bolls from maturing.

The strain Z.1-9 is a very uniform type, but tends rather to over-production of wood. It produces a big boll which opens well, and will probably do better with a wider spacing than was used in the trial. U.4 is not so uniform, in that it contains a number of different types, all of which offer promising material for further selection. It is a small-bolled type, fruiting prolifically even under adverse conditions, but in the above experiment it did not open its bolls as well as one would have desired. A.12 is a much smaller type than either of the above. It fruits freely, producing good quality lint, and opens its bolls very well. B.143 is a medium-sized type with characteristic grey-green foliage. It opens its bolls badly, making picking very difficult and expensive. The lint length is quite good, but the ginning percentage is low. Both Z.49 and B.180 are not quite good enough for dry land farming, under conditions of precarious rainfall, although B.180 might merit further trial on irrigated land.

With the exception of B.180, Z.49, and Uganda, all the varieties showed as high a standard of resistance to jassid as would be required when grown under field conditions. A.12 proved itself the most resistant of all the varieties, but both Z.1-9 and U.4 showed as high a degree of resistance as would be required in actual practice. Apart from Uganda, which succumbed early, Z.49 was the first to show symptoms of jassid attack, but towards the latter part of the season B.180 appeared to suffer more than Z.49.

The lint characters and boll weights of the above varieties are given in Table IV.:

TABLE IV.

VARIETY TRIAL.

Variety.	*Boll Weight (Grms.).*	*Ginning (Per Cent.).*	*Weight of 100 Seeds (Grms.).*	*Lint Length (Mms.).*
Z.1-9	6·2	32·6	11·5	27·1
Z.49	5·9	32·5	12·5	25·1
Uganda	4·7	32·8	9·2	25·5
U.4	4·8	37·0	9·4	29·7
A.12	6·0	34·7	10·5	28·0
B.143	6·2	30·4	12·8	28·6
B.179	6·1	34·1	12·8	26·8
B.180	7·4	33·0	14·1	26·6

Observation Plots.

Quarter-acre plots of the strains used in the Variety Trial were laid out with the kind co-operation of farmers in different areas.

Dinedor.—The plots were planted out on land owned by Mr. G. L. Wallis, situated in the lower middle veldt on the banks of the Umbulusi River.

The plots were planted on November 29 under excellent moisture conditions, and all the varieties germinated well. Unfortunately the stand was completely destroyed by a sandstorm which took place about a week after the cotton had germinated, and the plots were abandoned.

Swaziland Corporation Plantations.—This estate is situated on the low veldt, and is considerably hotter and drier than Bremersdorp. The varieties were planted in rows 3 feet 6 inches apart, with the plants 2 feet apart in the rows. The work was kindly undertaken by Messrs. Stapleton and Jennings. Conditions at the time of planting were not good; the plots were planted on November 24 following light showers, and did not receive a soaking rain until January 5. Germination was bad, the final stand being less than 50 per cent.

Conditions throughout the season were very bad; the total rainfall registered on the estate during the year only amounted to 17·65 inches, and of this amount 7·61 inches fell in the three months prior to planting.

The varieties U.4, A.12, and Z.1-9 have again demonstrated their superiority over the others, and have shown that they will produce a paying crop despite adverse conditions. In the final yields the varieties follow closely their order of merit in the variety trial. U.4, A.12, and Z.1-9 have again produced the heaviest crop in the order named, while B.180 and Z.49 come at the foot of the list.

The total yields are given in Table V.:

TABLE V.

Swaziland Corporation Plantations.

Variety	*Yield in lbs. per Acre.*
U.4	880
A.12	640
Z.1-9	580
Uganda	456
B.143	380
B.179	292
B.180	252
Z.49	172

Spacing Experiment.

The following experiment was laid out to test a jassid-resistant strain numbered Z.106 at two different spacings. The spacings used were:

1. Plants 6 inches apart in the rows, with rows 2 feet 6 inches apart.
2. Plants 6 inches apart in the rows, with rows 3 feet apart.

The yields were compared with that of Z.1-9 used as the standard, at a spacing 3 feet 6 inches between rows, with plants 1 foot apart in the rows. The plots used were four rows, 80 feet long; each spacing was repeated eight times with the standard on each side of it, giving sixteen comparisons with the standard for each spacing, on the half strip method.

The method of analysis of the results is the same as that adopted in the variety trial. The results are summarized in Table VI.:

TABLE VI.

Variety.	*Spacing.*	*Yield per Acre (lbs.).*	*Mean Yield per Half-Strip (ozs.).*	*Mean Difference from Adjacent Standard Z.1-9.*	*Standard Error (E) of Mean Difference.*	*Mean Difference (E).*
Z.106 ..	2 ft. 6 ins. by 6 ins.	442·0	92·4	12·3	5·13	2·4
Z.1-9 ..	3 ft. 6 ins. by 1 ft.	352·0	70·4	—	—	—
Z.106 ..	3 ft. by 6 ins.	364·5	78·3	5·1	5·26	0·97

Z.106 at a spacing of 3 feet between rows, with plants 6 inches apart in the rows, shows a decreased yield per acre as compared with the standard, but the mean difference, as compared with the standard error, is too small to be significant. The yield per acre of Z.106 at a spacing of 6 inches between plants with rows 2 feet 6 inches apart, shows an increase on the standard. The mean yield per two rows of Z.106 compared with the mean yield of the adjacent two rows of Z.1-9 gives a difference of +12·3 in favour of the former. This difference is 2·4 times as great as its standard error and is significant, the probability that such difference should arise by chance being less than 5 per cent.

Z.106 is a compact upright type with short fruiting branches, making it eminently suitable for very close spacing. It fruits and holds its bolls well, but opens its bolls badly, so that it is difficult and expensive to pick. Apart from the variety A.12 mentioned in

the variety trial, it showed itself more jassid-resistant than any other variety grown on the Station. Examination of the yields of the different pickings (Table VII.) shows Z.106 as being considerably earlier than Z.1-9.

TABLE VII.

Variety.	*Spacing.*	*First Pick (lbs. per acre).*	*Second Pick (lbs. per acre).*	*Third Pick (lbs. per acre).*	*Total (lbs. per acre).*
Z.106 ..	2 ft. 6 ins. by 6 ins.	299·5	99·5	43	442·0
Z.1-9 ..	3 ft. 6 ins. by 1 ft.	177·0	95·0	80	352·0
Z.106 ..	3 ft. by 6 ins.	249·5	75·0	40	364·5

The lint measurements and boll weights are given in Table VIII.

TABLE VIII.

Spacing.

Variety.	*Boll Weight (Grms.).*	*Ginning (Per Cent.).*	*Weight of 100 Seeds (Grms.).*	*Lint Length (Mms.).*
Z.106	4·3	34·3	9·7	27·3

Seed Multiplication.

The first general issue of seed of jassid-resistant strains was made at the commencement of the past season with Z.1 bulk seed, multiplied under Mr. R. C. Wood's supervision during the previous season. Parcels of seed, 25 lbs. and upwards, were distributed to applicants. On the majority of farms the seed was planted by hand, at wide spacings, with a view to further rapid multiplication. The results have been very encouraging; in many cases farmers who were issued with 25 lbs. of seed have returned 1,200 to 1,700 lbs. seed cotton to the ginnery.

Arrangements were made with farmers in widely separate areas for the multiplication of 2,000 lbs. of re-selected Z. seed, for general distribution during the coming season. The amount of seed returned to the ginnery from this multiplication is in the neighbourhood of 35,000 lbs. This amount would have been considerably more had not the multiplication areas on three farms suffered severely from adverse climatic conditions and bollworm attack. As already mentioned, Mr. G. L. Wallis, in the White Umbulusi district, had half

his multiplication area destroyed by a sandstorm in the early part of the season, while the stand on the other half was reduced considerably. The plots on the farms of Mr. P. J. Lewis, and of Messrs. Holland and Jennings, both suffered severe damage from bollworm attack. The attack was most severe on Messrs. Holland and Jennings' farm, and when it is considered, moreover, that the crop was grown on 17·65 ins. of rain, the return of 500 lbs. seed cotton per acre is remarkably good. This seed has been distributed to growers in Swaziland, and along with the Z. 1 bulk seed should ensure that the greater part of the cotton area will be under jassid-resistant strains during the coming season.

Multiplication of seed of the U.4 strain, which has proved itself a prolific cropper in every district in which it has been tried, will be carried out during the coming season. Arrangements have been made, with the kind co-operation of farmers, for the seed to be grown on both dry and irrigated land, and, provided the season is good, sufficient seed of this variety will be obtained to give every grower a small amount the following season.

Rotation Crops.

The small area of land available precluded any serious tests being attempted, but small plots of different crops which might prove useful for rotation with cotton were planted. Apart from cotton, the main crops grown in the territory in the past have been maize and Kaffir corn, both of them finding a ready market locally at satisfactory prices. The local demand for maize has fallen off considerably during the past year, and the adoption of better methods of cultivation by the native population, coupled with the increasing number of natives employed on farms, public works, etc., will tend to diminish the demand in future. The present cost of transport practically prohibits the growing of maize for export purposes, and it is very necessary to find other rotation cash crops which can be exported at satisfactory prices.

Sorghums.—Seed of seven varieties of South Indian sorghums was obtained from Mr. Parnell, Barberton, and planted in the beginning of November. Growth in all varieties was very vigorous, but all proved very susceptible to rust. All except two varieties, which were not so badly attacked by rust, were ratooned back to ground level in January, but both the ratooned and the other two varieties failed to give a crop.

Groundnuts offer more prospect of being a suitable rotation crop on the lighter soils. It is a hardy crop, stands drought well, and

has a good export value. The common variety grown in Swaziland is Virginia Bunch, an upright type which has given good results under suitable conditions.

Fifteen varieties were grown in small plots, and although no outstanding yields have been obtained, they will all be given a further trial on a bigger scale in the coming season. The best yields were obtained from some of the spreading types, but the reaping costs of the spreading varieties are so much higher than those of upright types, that it may prove more remunerative to grow a lower yielding upright type in preference to a higher yielding spreading variety.

Beans and Pulses.—The prevalence of the Cantharides or C.M.R. beetle limits the planting of the above crops for seed purposes. The danger from this source can be lessened by planting early in September provided the rains are early, or by delaying planting until January. Various types were planted during January and February.

Mung (*Phaseolus mungo*) grew well, but suffered from a weevil pest which attacked both flowers and unripe grain.

Soya Beans.—Three varieties of soya beans were grown, and of these a commercial variety, Yellow, promises well.

Tepary Beans succumbed completely to collar rot.

Two varieties of Pigeon Pea (*Cajanus indicus*), obtained from Bihar, India, were planted out in December. Both appeared to suit local conditions, and gave yields of 800 and 1,000 lbs. per acre. Reports on samples sent to the Johannesburg Market quote the price as £1 12s. 6d. per 200 lbs. From observations it would appear that planting before December would result in a higher yield being obtained.

The Hluba Bean (*Voiandria subterranea*), which has given good results elsewhere, failed completely on the red soil.

Insect Notes.

Jassid appeared soon after the January rains, and by the beginning of February its effect on the crop was very noticeable, the attack gradually increasing in severity until the end of March. The greatest damage was done by the pest in the low veldt areas, where the period of infestation coincided with the drought of February and March. In the Bremersdorp area the attack was not so severe and the late rains revived the crop.

The multiplication plots of jassid-resistant strains throughout the territory showed little effect, only a few individual plants showing themselves susceptible and these were rogued out.

Bollworm.—The incidence of bollworm attack during the season has been very slight, although a few individual farms suffered severely from Red Bollworm.

The American Bollworm (*Chloridea obsoleta*) attained no importance, although occasional larvæ were found during the early months of the season. The same may be stated with regard to Spiny Bollworm (*Earias insulana*). Considerable numbers were destroyed in trap crops of cotton in the White Umbulusi district during September and October, but little damage was done to plant cotton throughout the year.

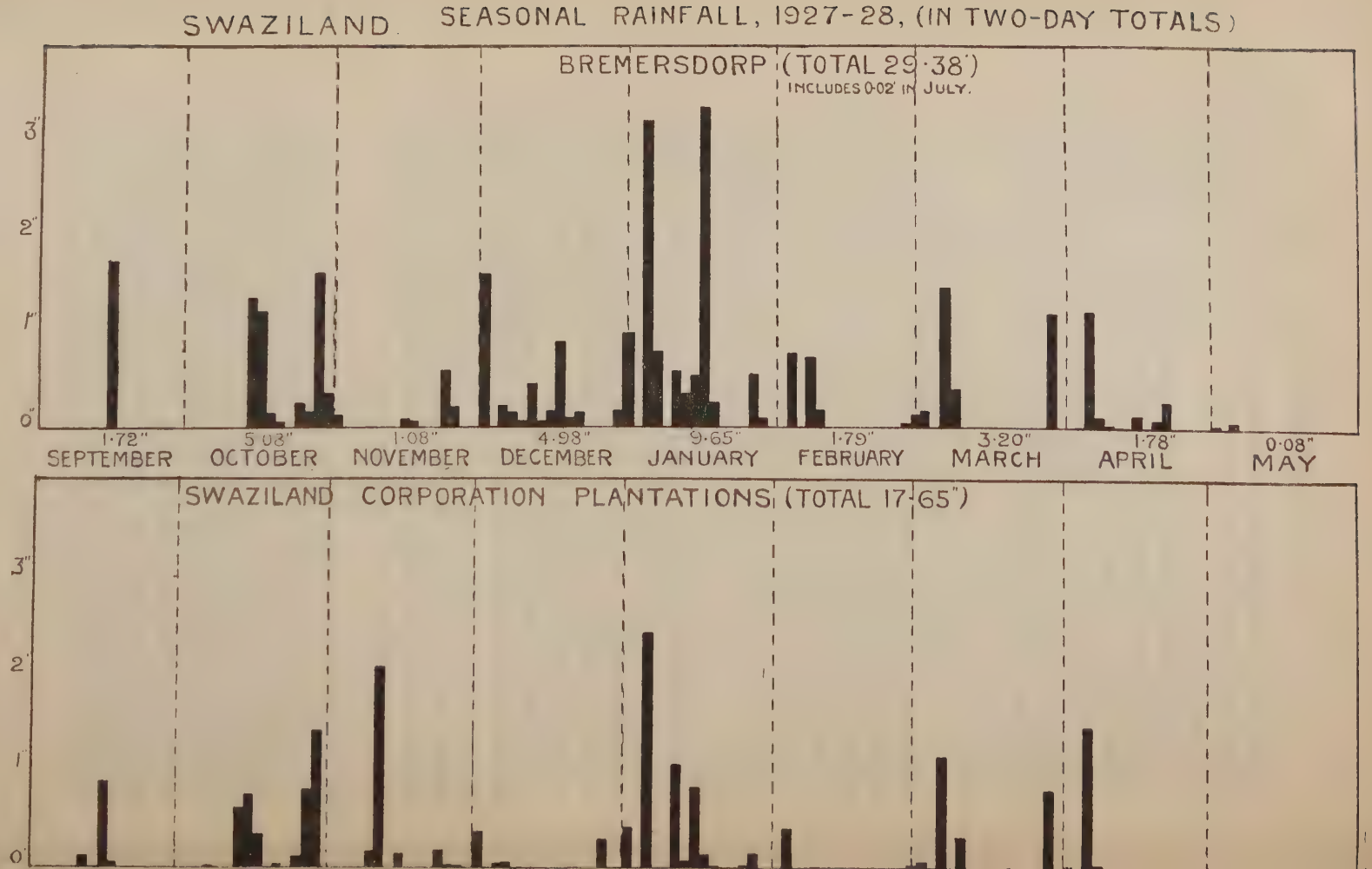
Red Bollworm (*Diparopsis castanea*): As mentioned above, only a few individual farms suffered from this pest. Its presence on plant cotton grown on the Station was noted as early as December 5, but the increase in numbers was very small until the middle of March, when a heavy infestation took place. Later in the season the pest disappeared, and little damage to the late crop was recorded.

Trap crops of ratooned cotton were utilized on two farms, the cotton being hand-stripped or grazed back by cattle during the early part of the season, when the bollworm condition justified it. Little can be said of the benefit derived by the plant cotton on the farms where the trapping was carried out on account of the slight amount of damage done by bollworm in the past season.

Cotton Stainers.—*Oxycarenus* sp. were present in large numbers from early March onwards, but Red Stainers (*Dysdercus* sp.) were not numerous until a month later. From then onwards they increased rapidly, and their effect on the later cotton pickings was very marked, the proportion of stained cotton increasing with successive pickings. Cotton-seed traps proved of little use until the bulk of the crop was picked, but they have given good results during the close season. At the time of writing (October) similar traps on the Swaziland Plantations lands are still attracting large numbers of stainers.

Transport and Communications.

Large sums of money have been expended by the Swaziland Administration during the past year in improving roads and communications generally. Cement weirs over all the rivers on the main Bremersdorp-Gollel road are in course of construction. A railway motor-bus service was inaugurated in January of the present year, and links up Swaziland with the railhead at Breyten in the north and Gollel in the south.


SWAZILAND SEASONAL RAINFALL, 1927-28, (IN TWO-DAY TOTALS)
BREMERSDORP (TOTAL 29·38")
INCLUDES 0·02" IN JULY.
3"
2"
1"
0"
1·72" SEPTEMBER
5·08" OCTOBER
1·08" NOVEMBER
4·98" DECEMBER
9·65" JANUARY
1·79" FEBRUARY
3·20" MARCH
1·78" APRIL
0·08" MAY
SWAZILAND CORPORATION PLANTATIONS (TOTAL 17·65")
3"
2"
1"
0"

SOUTHERN RHODESIA

REPORT ON THE WORK OF THE COTTON-BREEDING STATION, GATOOMA, FOR THE SEASON 1927-1928

INTRODUCTORY NOTE BY G. S. CAMERON.

THE accompanying report of the work done at the Cotton-Breeding Station, Gatooma, shows a marked advance over previous years in the quality of the material handled. This is due to the striking superiority over other strains of the U.4 seed received from Mr. Parnell, the officer in charge of the Corporation's Plant-Breeding Station at Barberton.

It was only a year ago that it was possible to state with any degree of definiteness that cotton-growing in Southern Rhodesia would be sure to succeed and that a strain of seed suited to the country could be evolved. Certain selections from Cambodia gave a distinct lead as to the nature of the selections which would require to be made, and work was planned accordingly.

An inspection of the U.4 plots at Barberton led one to hope that this particular strain of Parnell's might do equally well at Gatooma, and results now seem to indicate that those early hopes have been justified.

Seed of this strain has been multiplied at Gatooma, and further propagation will be carried out on about seventy farms in different parts of the country during the ensuing season. This will be done under a strict agreement with each farmer, whereby he undertakes *inter alia* to return to the Government 75 per cent. of the seed from his crop for a further and general distribution in 1929.

A perusal of the report will show that the season was such as to cause a severe strain on all cottons grown at the Gatooma Cotton-Breeding Station, but the U.4 cotton has weathered the adverse conditions better than any of the others.

How U.4 will behave in a wet season remains to be seen, and for this reason it is hoped that the ensuing year will give it an opportunity of demonstrating its behaviour under opposite conditions to those which it has experienced in the past.

During the year under review the Cotton-Breeding Station has

been completely fenced, and the general lay-out is now definitely fixed.

The station is now equipped with a 50-saw power gin, driven by a 10-20 h.p. tractor.

Permission has recently been obtained to lease an additional 143 acres of good land adjoining the station. This will materially assist in the rapid propagation of re-selected strains which it is desirable to get into general cultivation throughout the country as early as possible.

Grateful acknowledgment is again made of the unstinted financial support of the Government of Southern Rhodesia, and of willing assistance rendered by the Department of Agriculture.

COTTON-BREEDING STATION, GATOOMA: REPORT FOR THE SEASON 1927-28

BY
J. E. PEAT.

Real and very encouraging progress in the work of the station has been made in the season under review. Climatic conditions were far from favourable: rotation crops were a partial failure, yet with cotton good yields were obtained from jassid-resistant strains.

Jassid, though serious in its attack, was possibly not quite so bad as in the previous season, this being due probably to the effects of partial drought. The bollworm attack was small, and practically entirely due to Spiny Bollworm (*Earias spp.*). Stainers were numerous, but were again kept in control by trapping and hand-picking. Extremely little of the seed cotton harvested showed staining. Barberton U.4 was the outstanding strain grown. About 15 lbs. of seed were available for multiplication and a yield of 3,539 lbs. of seed cotton was obtained.

The great amount of variation in U.4 is recognized, but more uniform special bulk is being multiplied to replace it, and there is a large number of the single plant selections showing very great promise.

Season.

Rainfall.—As may be seen from Table I. (p. 112) the rainfall distribution was far from being satisfactory. The total, 18·05 inches, is the lowest in the Gatooma records.

RAINFALL—GATOOMA, 1927-28.

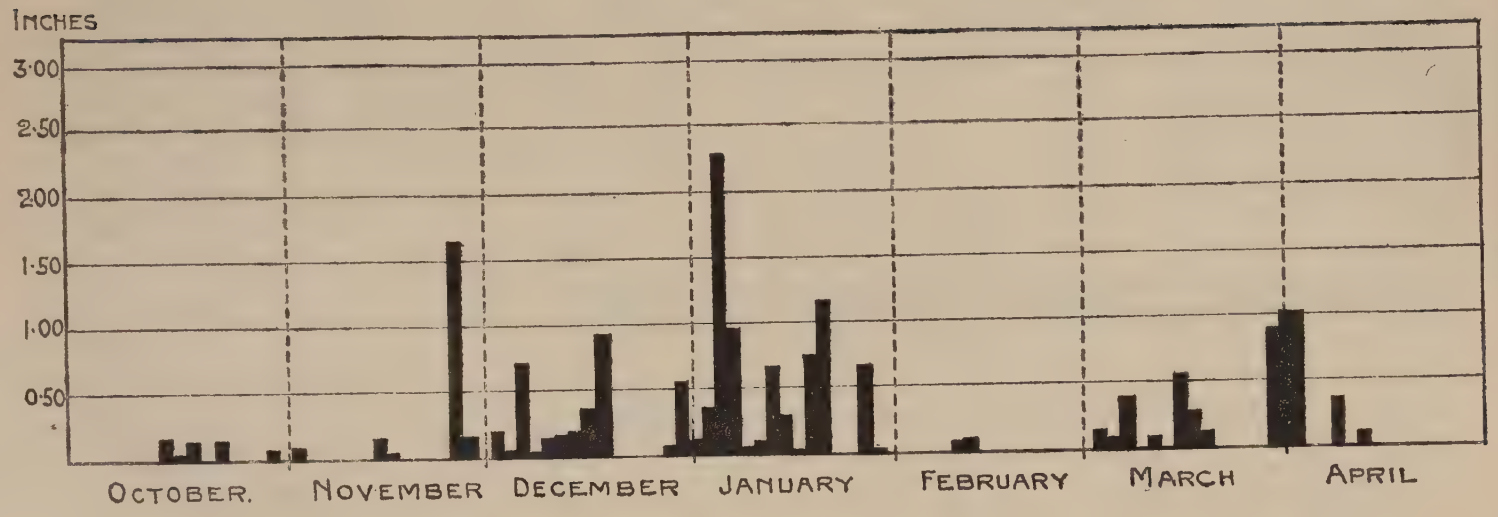


TABLE I.

RAINFALL RECORD (JULY, 1927, TO JUNE, 1928).

1927.		*Inches.*	
July ..	..	Nil	
August ..	..	Nil	
September	..	Nil	
October 16	..	0·17	
„ 18	..	0·04	
„ 19	..	0·14	
„ 23	..	0·13	
„ 30	..	0·07	
		——	0·55
November 2	..	0·09	
„ 14	..	0·05	
„ 15	..	0·07	
„ 16	..	0·01	
„ 17	..	0·02	
„ 26	..	0·01	
„ 27	..	1·60	
„ 29	..	0·14	
		——	1·99
December 2	..	0·03	
„ 3	..	0·15	
„ 4	..	0·03	
„ 6	..	0·15	
„ 7	..	0·56	
„ 8	..	0·02	
„ 10	..	0·11	
„ 11	..	0·01	
„ 12	..	0·10	
„ 13	..	0·03	
„ 14	..	0·17	
„ 17	..	0·34	
„ 18	..	0·02	
„ 19	..	0·89	
„ 29	..	0·06	
„ 30	..	0·02	
„ 31	..	0·52	
		——	3·21

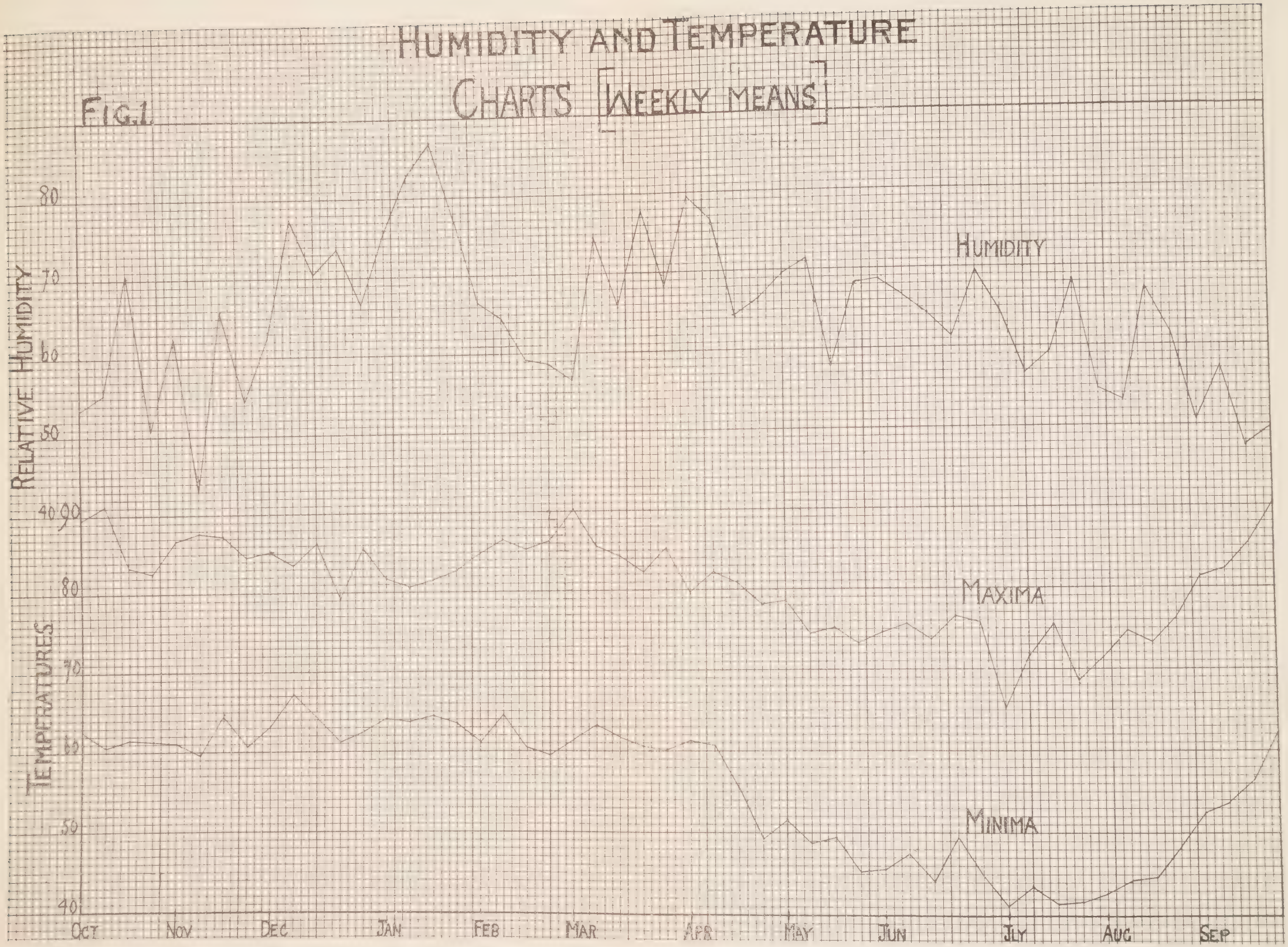
1928.		*Inches.*	
January 2	..	0·11	
„ 3	..	0·32	
„ 4	..	0·02	
„ 6	..	2·25	
„ 7	..	0·53	
„ 8	..	0·44	
„ 9	..	0·02	
„ 11	..	0·09	
„ 13	..	0·07	
„ 14	..	0·59	
„ 15	..	0·16	
„ 16	..	0·11	
„ 18	..	0·02	
„ 19	..	0·76	
„ 21	..	0·12	
„ 22	..	1·05	
„ 28	..	0·63	
„ 30	..	0·01	
		——	7·30
February 10	..	0·04	
„ 13	..	0·05	
		——	0·09
March 4	..	0·12	
„ 5	..	0·03	
„ 6	..	0·04	
„ 7	..	0·38	
„ 11	..	0·06	
„ 12	..	0·01	
„ 16	..	0·55	
„ 17	..	0·25	
„ 19	..	0·10	
„ 29	..	0·05	
„ 30	..	0·84	
„ 31	..	0·86	
		——	3·29
April 1	..	0·16	
„ 2	..	0·81	
„ 3	..	0·21	
„ 9	..	0·35	
„ 12	..	0·09	
		——	1·62
May ..	..	Nil	
June ..	..	Nil	
Total rainfall for year			18·05 ins.

The first good rain was late, falling on November 27, and the remainder of the planting rains were only fair. A reduction of the possible stand was undoubtedly caused by the lightness of the early rains, all the more so as the greater part of the area had to be planted with single seeds. The plants, however, got away well in January.

A serious drought occurred through February and March, which did not really break until the end of the latter month. It affected

FIG. 1.

HUMIDITY AND TEMPERATURE CHARTS [WEEKLY MEANS]



very severely the tobacco, ground nuts, and maize in the district, the later-planted maize yielding nothing at all. Contrasted with these other crops cotton again showed its remarkable powers of drought-resistance, and in the circumstances the ultimate yields obtained are remarkable. But the plants suffered, especially at the closer spacings, where, as is shown in the development records, the competition for moisture must have been much more acute than in the widely spaced single-plant lots. Growth and flowering stopped, and a great deal of boll-shedding also must be attributed to the drought. Following the rains at the end of March and beginning of April growth and flowering restarted, but this was relatively late in the season. Plants were stunted and the later bolls were maturing during a period of low temperatures. As a result, the bolling season has been a very long one, bolls continuing to open until well into September. With the falling temperatures this is not so satisfactory as a more normal season would have been. Through the stoppage in plant growth and flowering, and through boll-shedding, a serious drop in possible yield was caused by the drought.

Temperatures and Humidity.—Fig. 1 gives the maximum and minimum temperature and the humidity charts for the season. They are plotted with weekly means. During February and the first part of March, temperatures were relatively high and the humidity extremely low; there was much high wind, and during February the sunshine records show a mean of 9·7 hours of sunshine per day—trying weather for the young growing plants.

Frost was not experienced; the lowest temperature recorded was 35·4° F. on July 26. The lowest weekly mean was 41° F. at the end of June. But from the end of April night temperatures were low, the weekly means ranging between 40° and 50° F. Yet, as may be seen in the later records, bolls opened well in jassid-resistant strains in May, June, and July, and even fairly well in August and September: the boll-development period for the later-formed bolls was long. Considerable second pickings of good-quality cotton were made, and moderate third pickings of quite fair cotton. In most seasons the last of a commercial crop should be available for picking in July. The manner of opening of the jassid-resistant strains during the colder months was exceedingly interesting.

Other Meteorological Records.—Sunshine records were kept; they were high, but for a season such as last the full details are not of very great interest.

Sun and soil temperature records and thermograph records were also kept.

Plant Development Records.

Development records were taken for three strains—Commercial Improved Bancroft, and the two Barberton strains most likely to replace it, U.4 and A.12. All the graphed records (Fig. 2) show extremely well the nature of the season, divided into two portions by the period of drought, but as a result of the drought they do not bring out clearly the benefits possessed by the jassid-resistant strains over the non-resistant variety Bancroft.

Four record plots, distributed with the maximum of scatter, were planted for each strain. Records were taken from two lines in each plot, eight distinct lines for each strain.

The plots were planted on November 29, 4 feet by 10 inches, and thinned on January 3. The general fertilizer dressing of 150 lbs. per acre of bone and superphosphate, plus 50 lbs. per acre sulphate of ammonia, was given at planting.

Growth records, measuring from the cotyledonary node to the base of the apical bud, were taken every second day, starting with eighty healthy plants of each strain, twenty to each plot.

Flowering and boll-shedding records were taken daily, starting with 200 plants of each strain, fifty in each plot. As was done last year, the shed bolls were divided into those showing and not showing bollworm puncture.

Bolling records were taken weekly on the same lines of plants as the flowering and shedding records. Again the bolls as they were picked were divided into two classes, mature and immature.

As last year, growth has been reduced to growth per plot per day and smoothed to five-interval, ten-day means; flowering and shedding figures are smoothed to five-day means, and the bolling figures represent bolls per plant per day with weekly pickings.

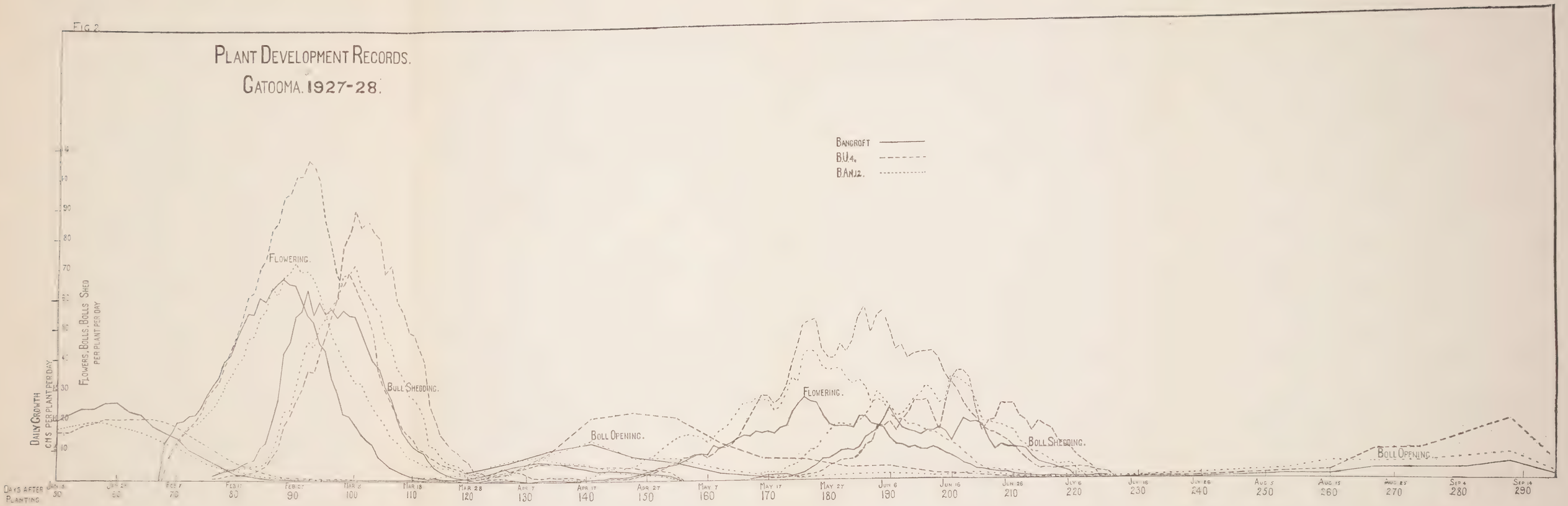
Growth.—With the close spacing of the record plots and the drought experienced, the competition for moisture must have been acute. Growth was poor and the plants were stunted. The growth rate declined after the end of January, when normally the plants would have been at their most vigorous stage, and by the end of February they had practically ceased growing. U.4 shows the best growth curve, and shows itself less affected by the drought than Bancroft or A.12. Growth started again after the March rains and plants were making slow growth through April.

Flowering.—Flowering started on February 5, and the graph shows the flowering rate rising rapidly to a peak at the end of February. Owing to the effects of the drought on the plants, flowering fell off

FIG 2.

PLANT DEVELOPMENT RECORDS.

GATOOMA. 1927-28.



rapidly in March, and by the end of the third week had practically ceased. As a result of the March rains flowering started again towards the end of April and continued into July. The bolls from the later-formed flowers were developing in a difficult period of low temperatures. The dry spell had the effect of cutting out the optimum period of flowering, March and April, and so seriously restricting the possible yield.

U.4 flowered much more freely than either of the other two strains, and A.12 more freely than Bancroft. This was especially noticeable in the second period of flowering, by which time Bancroft was suffering from the effects of jassid attack.

All three strains are fairly early maturing.

Boll-shedding.—The boll-shedding rate is high, but with a severe competition for moisture at the critical period this is to be expected. Less shedding took place in the wider-spaced multiplication plots.

The shedding curves follow closely the shape of the flowering curves, with a lag of eight and nine days in the first period.

Shedding took place round about the eighth and ninth day in the life of the young boll. Little of the shedding in the first period is due to the effects of jassid attack, but Bancroft is affected in the second period. Totalling the shed bolls of the three strains, 9·7 per cent. showed bollworm punctures.

Bolls Opening.—As a result of the narrow flowering curves and the high shedding, the bolling curves are low, again distributed in two periods. U.4 is markedly superior to the other two strains.

Although, as a result of the season, the total mean yields per plant in the record plots are small, U.4 yielded more than twice as heavily as Bancroft, and half as heavily again as A.12—30·6 gms. per plant as compared with 14·8 gms. and 20·2 gms. respectively. The bolls are smaller than those of A.12 and Bancroft, but are thin-walled, and weighed out heavier than was expected. In the first period the mean boll weights for U.4, excluding the obviously immature and attacked bolls, ranged around 3·4 to 3·5 gms., as contrasted with 4·2 to 4·3 gms. for A.12 and 3·7 to 3·8 gms. for Bancroft. Later in the season mean boll weights were slightly less.

The boll-development period for the first flowers produced was around fifty-four days. Bolls opening later in April were taking fifty-eight and fifty-nine days to develop, and towards the middle of May more than sixty days, even as much as seventy days. Bolls opening later in the season were slow in developing.

Insect Attack: Jassid.

Jassids were again the most serious insect pests, and were again the limiting factor in determining the behaviour of the various strains grown. Speaking generally, resistant strains gave good results; intermediate strains gave intermediate results; and the more susceptible strains gave very poor yields. Except for the purpose of demonstration, no strain or variety is being continued which does not show a high degree of jassid resistance.

Blocks of Durango, the most susceptible variety grown, were planted scattered through the observation blocks and single-plant lots as indices of the attack and as breeding grounds for jassids. They served both of these purposes well.

Nymph Counts.—It is probable that owing to the period of drought the sum of the jassid attack, though severe, was not so bad as last season. Odd nymphs were noticed in plants both of resistant and susceptible strains about the middle of January, especially at this stage in the bigger plants, and weekly nymph counts were started at the end of January. The results for twelve of the more interesting strains are set out in Table II. (p. 117).

Five representative, fairly well grown plants were chosen for each strain. Each week nymph counts were made to give a good indication of the attack, but no allowance could be made for differences in leaf size, plant size, plant vigour or resistance to the effects of the drought. Throughout, counts were made on the leaves which observation showed probably to be carrying the most nymphs. At first these were leaves fully grown or almost fully grown, but later in the season, in the more susceptible strains, the young leaves were small and crumpled, and counts were made on these in preference to the more fully grown older leaves.

The numbers on the more susceptible strains increased through February, but decreased considerably in March. Plants were suffering from the effects of the drought, and it is probable that the dry conditions were not favourable to the multiplication of the jassids. After the rains at the end of March the numbers increased again in April, but decreased in May as the susceptible plants, in succumbing, became unattractive.

Intermediate and resistant plants show a few nymphs present early in the season, but later few were to be found on them. Practically in order of plant susceptibility numbers increased again on the plants in April at the conclusion of the drought, by which time the more susceptible strains were proving unattractive. With the advent

TABLE II.—WEEKLY JASSID NYMPH COUNTS (1927–1928).

Counts on Twenty-Five Leaves (Five Leaves on Each of Five Plants).

Strain.	31/1	7/2	14/2	21/2	28/2	6/3	13/3	20/3	27/3	3/4	10/4	17/4	24/4	1/5	8/5	15/5	22/5	29/5	5/6	12/6	19/6	26/6	*Totals.*
B.C. 8/29	1	1	—	2	1	—	1	—	—	—	—	—	2	2	1	1	1	—	1	—	—	—	14
G.C. 4	13	5	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20
B.U. 4/4/8	7	4	5	3	3	—	2	1	2	1	—	—	4	8	2	4	1	—	—	—	—	—	47
B.A. 12	—	6	5	3	—	—	—	—	—	—	—	—	19	14	7	1	1	—	—	—	—	—	56
B.U. 4	8	17	15	3	—	3	3	2	—	3	—	1	3	3	10	9	1	—	—	—	—	—	81
G.A. 1/5	4	10	15	12	6	6	3	3	2	4	3	6	23	15	6	1	1	—	1	1	—	—	122
B.B. 179	5	11	11	6	4	3	—	4	1	2	7	1	18	29	8	10	5	5	—	—	—	—	130
G.B. – 0/1	5	5	2	1	—	—	—	1	—	—	18	28	29	42	24	15	4	1	1	—	1	—	177
G.D. 4/9	8	32	10	2	—	1	—	9	1	1	22	94	54	25	27	30	5	—	—	—	—	—	321
Bancroft	10	12	29	9	18	18	17	11	5	8	5	9	32	40	38	55	29	18	8	4	1	2	378
Acala (A 5A)	36	54	40	73	101	220	55	74	52	20	7	13	20	13	31	31	27	16	4	4	—	—	891
Durango	16	41	32	57	146	139	163	133	51	23	38	59	35	45	29	23	46	32	14	14	—	—	1,136

of the dry weather and the colder temperatures the attack died away.

Fig. 3 gives the seasonal distribution of jassids for Durango (the most susceptible strain grown), Bancroft, and U.4 respectively.

Hairiness and Resistance.—Further examination of the relationship between hairiness and resistance was made. The results support the conclusion already arrived at, that, speaking generally, and taking both the area density and the hair lengths into consideration, the hairier the plant the greater its resistance.

TABLE III.

HAIRINESS AND RESISTANCE (1927-28).

Strain.	*Mean Number of Hairs per Square Mm.*	*S.E. of Mean.*	*Mean Hair Length (Mm.).*	*Resistance.*
B.Z. 106	9·6	0·43	0·71	Good.
B.Z. 49/6	9·4	0·46	0·62	Good.
G.B. −0/2	7·7	0·40	0·59	Fairly good.
B.Z. 1/9	7·0	0·38	0·66	Good.
B.B. 179	6·8	0·28	0·71	Good.
B.A. 12	6·7	0·54	0·86	Good.
B.C. 8/29	6·6	0·24	0·98	Good.
B.U. 4/4/8	5·7	0·35	0·70	Good.
B.U. 4	5·2	0·32	0·87	Good.
G.B. −0/1	5·3	0·30	0·71	Fairly good.
G.A. 1/5	3·8	0·23	0·77	Fair.
G.D. 4/9	3·0	0·22	0·81	Slightly resistant.
Bancroft	2·0	0·19	0·62	Slightly resistant.
Durango	0·2	—	0·71	Very bad.

In preparing the records given in Table III. twenty full-grown leaves were used for each strain, two leaves from each of ten plants. A narrow strip was cut from between the junction of the main leaf veins; this strip was mounted between two slides, and the number of hairs counted under the low-power field of view of the microscope, an area of 3·14 sq. mm. The number of hairs was counted for two fields of view for each leaf. Thus for each strain forty density estimations were made.

Using an eyepiece micrometer, hair lengths were measured on five hairs in the microscopic field of view for ten leaves of each strain, fifty measurements. The measurements were made on random hairs, and not, as last season, only on the larger hairs. Interesting observations are, that within a strain with a denser concentration of hairs in the microscopic field the mean hair lengths tend to be shorter;

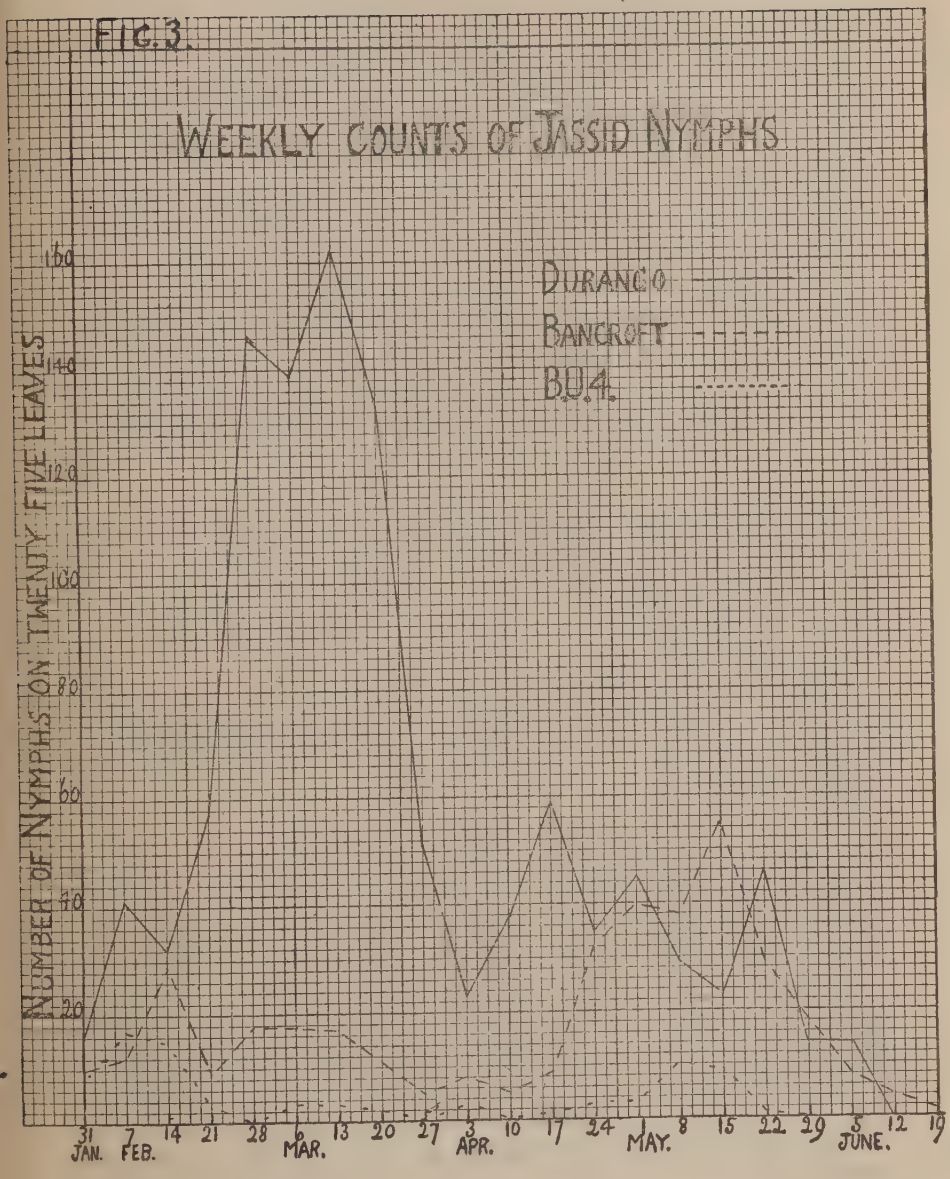


FIG. 3.
WEEKLY COUNTS OF JASSID NYMPHS
DURANGO
BANCROFT
B.U.4.
NUMBER OF NYMPHS ON TWENTY-FIVE LEAVES
160
140
120
100
80
60
40
20
31 JAN.
7 FEB.
14
21
28
6 MAR.
13
20
27
3 APR.
10
17
24
1 MAY.
8
15
22
29
5 JUNE.
12
19

and, again, that towards the end of the season the newer leaves appear to be less hairy.

The most resistant strains, the Cambodia single-plant lots, have a good density combined with high mean hair length, and as shown in Table II. are attacked to a very small extent by jassids. B.Z. 106, B.Z. 49/6, B.Z. 1/9 with a greater density and shorter hairs show, if anything, slightly less resistance. B.A. 12 shows very good resistance. G.B. -0/2 is interesting. The hair density is high, but the mean lengths low, and its resistance would not appear to be as good as the less dense U.4 strains. This is slightly complicated, however, by the fact that G.B. -0/2 and G.B. -0/1 are probably not as good drought resisters. The U.4 strains, though less resistant than several of the other lots, show good resistance, especially in bulk, and appear to be quite resistant enough for commercial conditions. G.A. 1/5, G.D. 4/9, and several others, though better than Bancroft, do not show sufficient resistance to justify their continuance. Durango is the most jassid-susceptible variety grown, followed closely by Acala (Table II.).

Cage experiments were repeated with 1,600-mesh gauze cages. Jassid nymphs were introduced into some at intervals, and others were used as controls. While the experiments were satisfactory as demonstrations, they were complicated by recurring attacks of aphis in the caged plants.

The commercial crops of Improved Bancroft seen by the writer during the season were all suffering distinctly from serious jassid attack, while plots of Cambodia distributed for demonstration purposes escaped.

Stainers (*Dysdercus spp.*).

It is probable that with jassid under control, stainers and bollworms will be the two most serious pests with which cotton-growers in this Colony will have to deal. Good results have been obtained on the station for the last two years in the control of stainers by trapping and by hand-picking—this season, an abnormally dry one, and last season, a season of good average rainfall. It remains to be seen what measure of success will attend these methods in a wet year.

The first stainer was noticed at the end of January, but throughout February only a very few odd adults were observed. Seed-cotton traps, similar to those used last year, were set down during the third week in February, but with practically no success. During the first week in March there appeared to be an invasion of adult stainers from the surrounding veld, and there was a marked increase in the number

of stainers to be seen in the lands, though still really relatively few. The majority were pairing. New traps were put down, and at the same time hand-picking was started. Traps were arranged as they were last year, but were not so successful in the trapping of adults. Their great value this season lay in the fact that the earlier broods hatched out on them and were easily killed. The majority of the adults caught were caught on the plants. Big heaps of seed under shade were also tried, but were not successful.

No nymphal broods were observed until March 30, but numerous broods, newly hatched out, were observed on the traps in early April. Traps were renewed every fortnight and the old seed burned. A large number of broods were destroyed during April and May, but despite this a considerable number of adults were caught right through until the middle of June. There must have been a steady invasion of adults from the surrounding veld.

Table IV. gives a record of the catches of adult stainers caught on the traps and hand-picked from the plants.

TABLE IV.

STAINERS: WEEKLY CATCHES, MARCH 8 TO JUNE 30.

Week Ending—	*10½-Acre Experimental Block.*	*36½-Acre Multiplication Block.*	*Total.*
March 14, 1928	3,672	—	5,105
(March 12 to 14, 1928) ..	—	1,433	
March 21	5,056	4,730	9,786
March 28	4,024	6,684	10,708
April 4	5,553	6,207	11,760
April 11	5,660	10,094	15,754
April 18	5,642	7,510	13,152
April 25	2,779	5,354	8,133
May 2	2,533	5,798	8,331
May 9	3,010	6,196	9,206
May 16	4,396	6,019	10,415
May 23	2,931	6,044	8,975
May 30	4,641	7,680	12,321
June 6	3,147	4,838	7,985
June 13..	1,760	2,560	4,320
June 20..	1,088	734	1,822
June 27..	777	646	1,423
June 28 to 30	189	203	392
Totals	56,858	82,730	139,588

The drought during February and March must have delayed multiplication to quite an extent, and the smaller success this year of the seed traps as traps for adults is believed to be due to the com-

parative absence of showers after they were put down. The sharp ending of the rains in March and the length of the dry season, combined with low dry-season temperatures, will probably be important factors in making the control of stainers possible in Southern Rhodesia. Moisture would appear to be one of the most important factors affecting the bionomics of *Dysdercus*.

By the combination of trapping and hand-picking almost complete control was effected. Practically no stained cotton was harvested, and there was hardly any sign of stainer damage in the lands, yet a total of more than 140,000 adults must have been killed, many of them heavy with eggs, and hundreds of broods were destroyed on the traps and elsewhere. On 10½ acres, the experimental, record, and selection block, some 60,000 adults were killed. By the end of the season stainers were difficult to find in the lands.

The number of natives employed on this work varied throughout the season, but in both seasons, in a country such as Southern Rhodesia, with intelligent white farmers and fairly cheap native labour, similar control work could have been carried out economically on a farm scale. Next season it is suggested that a certain amount of stainer control work be attempted in the U.4 multiplication plots in the districts. This would be on a farm scale and would be economically conducted.

This season an attempt was made to obtain some records of the natural food plants in the veld around the station, but with little success. Next season it is hoped to proceed with the study of the flora around the station, and if assistance can be obtained, in Mazoe and Lomagundi, with a view to recording, as a first step to controlling, possibly, the natural food plants of the stainer and the Sudan Bollworm.

Cages and Traps.—Stainers were introduced at intervals into single-plant cages with adjacent controls. The characteristic stainer damage occurred in the stainer cages, and when contrasted with the controls a very good demonstration was effected.

Into the big bee-proof cage a considerable number of stainers were introduced at various times throughout the season, and a beginning made with the study of the most suitable traps. With the season experienced this year, crushed and uncrushed cotton seed appeared to have much the same attractive value, but both, soaked in cotton-seed oil, attracted but few stainers.

Next season it is proposed to continue this work much further. Substances which will be tried as baits by themselves, and added to cotton seed, crushed and uncrushed, will be molasses, syrup-

treacle, honey, linseed, a solution of vanilla in alcohol, and discarded citrus fruit. Further notes will be made on the possibility of making more use of moisture and shade in trapping.

Bollworms.

Again this season the shedding due to bollworms on the station has been relatively small, and the loss has been caused almost entirely by Spiny Bollworms (*Earias spp.*). A very few American Bollworms (*Chloridea obsoleta*) were seen, but no Sudan Bollworms (*Diparopsis castanea*). Late-planted maize and sweet corn were again planted as trap crops for American Bollworm, but were not attacked. These will be repeated next season.

Fig. 4 (facing p. 124) shows the distribution of the bollworm attack.

Totalling the three strains of which records were taken, 9·7 per cent. of the bolls shed showed bollworm punctures—10·2 per cent. in U.4, 10·5 per cent. in A.12, and 8·3 per cent. in Bancroft. The curve follows the same lines as the shedding curves. A fair amount of early bud-shedding also was caused by Spiny Bollworms.

Diparopsis, though apparently not present around Gatooma, is present at least in Bulawayo and in Mazoe Valley. A parcel of young bolls sent to the writer in March from Bulawayo had a 20 per cent. infestation of *Diparopsis*, and during a short tour of Mazoe Valley with Ducker in April several attacked crops of Improved Bancroft were seen. It is hoped next season to get a comparison made between the flora of Gatooma and of Mazoe, and some study made of natural food plants. Methods by which *Diparopsis* is being attacked in the Union and in Nyasaland are being watched with a view to their possible adoption in this country. A small plot of cotton will be ratooned on the station next season, amongst other reasons for the study of possible bollworm and stainer attack.

Aphids.

Aphids were troublesome in February, but practically disappeared in March. They became noticeable again towards the end of April, and were quite bad in May and June. They must have done a certain amount of damage, and the honey-dew on the leaves and opening bolls caused the plants to look unsightly. The season was probably favourable to their multiplication. Natural enemies were active—ladybirds, syrphid larvæ, and other dipterous enemies. The presence of aphids rather complicated the cage experiments. A nicotine and soap emulsion proved very effective in treating them there.

Wireworms (*Tenebrionidæ*).

At the planting season considerable trouble was caused by wireworms, larvæ of Tenebrionid beetles, chiefly the larvæ of *Trachynotus geniculatus*, and possibly also of *Zophosis* and *Gonocephalum simplex* F. They attacked the germinating seed and the very young seedlings. They appeared to be numerous in parts of the U.4 multiplication land, and reduced the stand considerably. Single-seed planting increased the seriousness of the attack. Poisoned baits were put down, but it is doubtful if they were effective. Through the co-operation of the Chief Entomologist of the Department of Agriculture, Mr. Cuthbertson, Assistant Entomologist, carried out some experiments in baiting the adult beetles with a view to preventing an attack next season. He appeared to be very successful, and at the conclusion of the baiting few adults could be found alive.

The most effective bait was Paris green 1 lb., maize meal 180 lbs., made into a thick porridge with water. Small portions were scattered through the lands under shade, debris or grass. These baits became re-effective on being remoistened when further adult beetles had emerged.

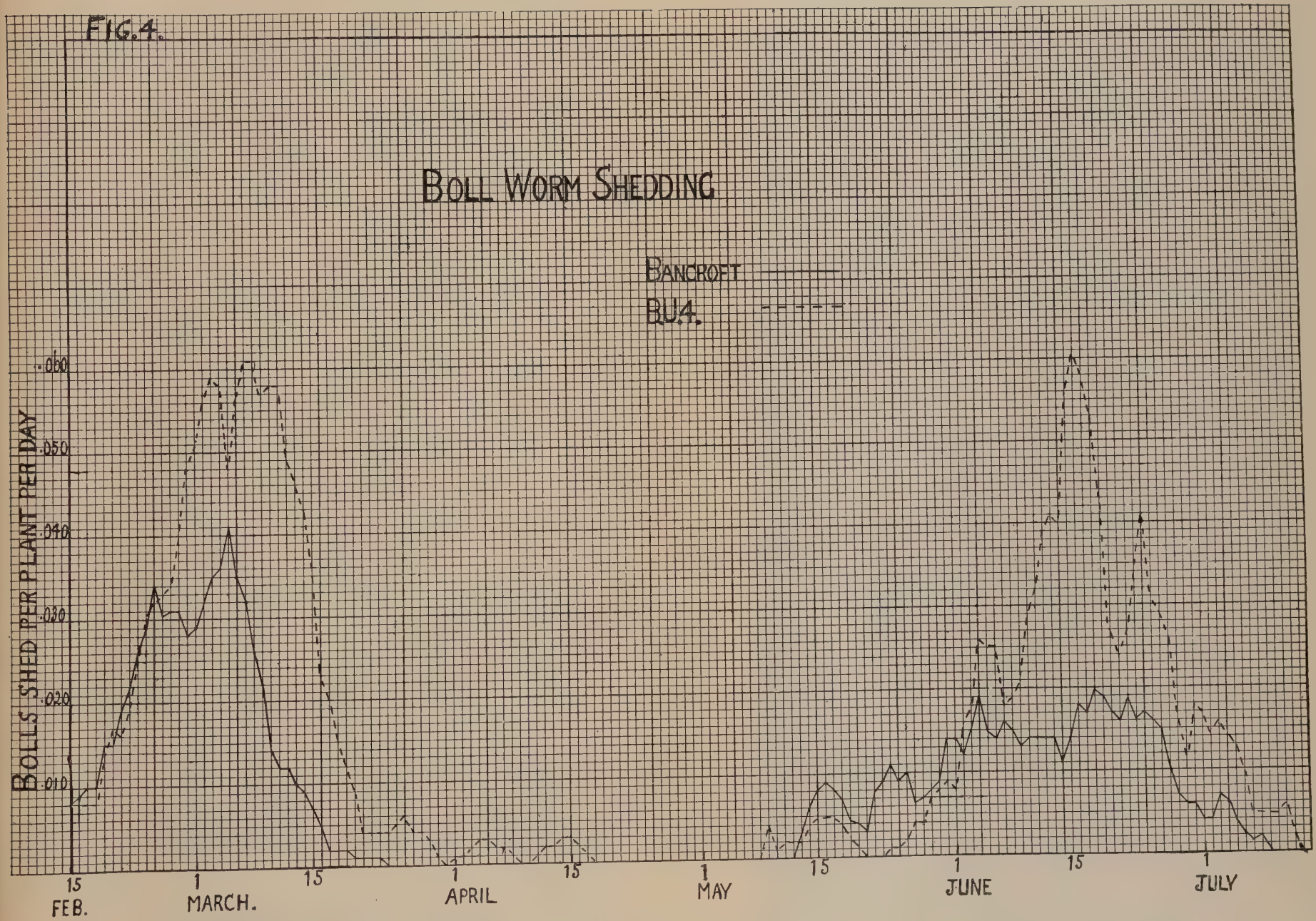
Termites.

Termites were again troublesome in reducing the stand. At the time of planting, powdered kraal manure was used to cover the seeds to assist brairding, only single seeds being planted. Termites were attracted to the kraal manure, and there is a risk that, as a result, they attacked a certain percentage of the young seedlings. This method will be discontinued next season. In the record plots, where the plants were being examined daily, 5 per cent. of the plants that were being measured died as a result of termite attack between January 20 and February 9.

Records of termite damage were kept on eighteen plots containing over four thousand plants. During the period between January 12 and February 10 the loss incurred was 1·3 per cent. During the next two weeks 3·1 per cent. of the remaining plants were lost, and a further decrease of 1·6 per cent. occurred in March.

Feeding the termites was tried by placing grass between the rows of certain plots, and comparing the attack in these plots with controls. No conclusion was reached.

FIG. 4.


BOLL WORM SHEDDING
BANCROFT
BU4.
BOLLS SHED PER PLANT PER DAY
.060
.050
.040
.030
.020
.010
15 FEB.
1 MARCH.
15
1 APRIL
15
1 MAY
15
1 JUNE
15
1 JULY

Angular Leaf Spot (*Pseudomonas* [*Bacterium*] *Malvacearum*).

In January a mild attack of Angular Leaf Spot was noticeable in certain of the strains; the older leaves were attacked. All the Gatooma material, especially Bancroft and Durango, and the Barberton strains were affected, but none of the introduced varieties, which had been treated with sulphuric acid prior to sowing. The new leaves produced in February and March were not attacked, nor were the bolls, but Angular Leaf Spot might be more serious in an abnormally wet year.

Varieties and Strains.

The uniform fertilizer treatment adopted was 150 lbs. of bone and superphosphate plus 50 lbs. of sulphate of ammonia per acre. The observation planting was 4 by 2 feet and for multiplication 4 by 3 feet.

Between the multiplication blocks belts of maize were planted, mainly to reduce as much as possible cross-pollination between the blocks, but at the same time they acted as shelter belts to the growing cotton plants. A few rows of later-planted maize in each long belt acted as a trap for American Bollworm.

Twenty-seven American varieties introduced from the United States were grown in small plots under observation. No one showed sufficient jassid-resistance to justify its continuance, nor were any single-plant selections made from this material.

Bulk Nyasaland Over-the-Top and two Makwapala substrains, M.O.B. 30/1 and M.O.A. 2/27, were grown, with disappointing results, nor did the Gatooma Over-the-Top selections justify their continuance. They all definitely suffered from the drought conditions. Plants were stunted, and though fairly jassid-resistant, the bolls did not open well. The strain would appear to be shallow rooted, and never looked really at home. Most of the lint examined was short.

The Rustenberg Bancroft strain, the Gatooma Delfos, and all the Gatooma Bancroft selections, with the exception of two, have now been discarded as insufficiently jassid-resistant. Selections from G.B. -0/1 and G.B. -0/2 show promise. A small plot of commercial Bancroft from selfed seed will be kept going for demonstration purposes.

Cambodia.—The Gatooma Cambodia strains still show promise. They were all very highly jassid-resistant. Several of them were reasonably compact and gave satisfactory yields. Some very good re-selections were obtained. Very good re-selections were also

obtained from B.C. 8 and B.C. 8/29, Barberton Cambodias. Table V. gives an indication of some of the more interesting yields. With single seeding the stands were poor. Good yields would have been obtained with fuller stands.

During the flowering season a large gang of natives was employed selfing in the selection plots. The same method was used as last year, cheap tobacco twine, unravelled, being used ultimately for tying up the flowers.

As far as possible the records in the single-plant analyses were taken from the five best bolls of the first picking for each plant. By so doing, medium-sized samples gave fairly uniform results for the comparison of selections. Later, wider samples will be taken from representative selections to compare the analyses so obtained with the more optimum analyses from the five best bolls. At the same time analyses will be made on the second and third pickings, so that some idea of the effects of the season may be recorded. It is hoped later to make a number of breaking-load and lint-uniformity tests on various selections and pickings. These results should be available next season. The mean maximum lint length was measured as last year from ten combed seeds. The ginning percentage, lint index, and mean weight of 100 seeds were estimated, using 300 seeds.

Table VI. (p. 128) gives analyses of some of the more interesting reselections.

In all a total of 308 selections were made on field characters; of these, forty-three were discarded after laboratory examination.

Barberton Strains.—It is with gratitude that the writer acknowledges the debt which is owed to Parnell for these strains.

*U.*4.—Twelve Barberton strains were grown under observation and multiplied (4 by 3 feet, single seeds) at Gatooma this past season. Of these, U.4 was easily the most outstanding. As the first multiplication from a single plant it is difficult to speak of it too highly. The bulk shows wide heterozygosity in plant habit, seed cotton, and lint characters, as is to be expected from the first multiplication; but as a bulk it yields well, and it would appear to be sufficiently jassid-resistant for commercial conditions. It is only because of the very real and immediate demand for seed of a jassid-resistant strain likely to give a profitable return that a first bulk is being issued. From it a large number of single-plant selections of the very highest promise have been obtained, and a special bulk of fairly uniform material will be multiplied up next season, which, with the discarded U.4 single-plant lots, will replace the more heterogeneous first issue.

The special bulk and the majority of the single plants will tend

TABLE V.

YIELDS FROM VARIETIES AND CAMBODIA STRAINS.

Strain.	*Number of Rows per Plot.*	*Yields per Plot.*			*Totals (Lbs.).*	*Total Yields per Row (Lbs.).*	*Total Yields per Plant (Gms.).*	*Total Yields per Acre (Lbs.).*	*Percentage Stand at Picking.*
		First Picking (Lbs.).	*Second Picking (Lbs.).*	*Third Picking (Lbs.).*					
GC–2	9	20·92	9·40	9·03	39·35	4·37	89·60	476·1	42·2
GC–6A	6	21·48	0·48	4·90	26·86	4·48	67·20	488·9	56·6
GC–7	7	20·81	3·96	4·85	29·62	4·23	116·48	462·1	32·3
GC–8	13	35·19	7·65	12·69	55·53	4·27	58·24	466·5	64·6
GC–10	11	27·30	7·76	11·09	46·15	4·19	76·16	452·3	49·1
GC–664–1	11	14·96	9·05	12·79	36·80	3·35	58·24	360·6	49·4
R.B.–F	4	7·17	0·25	1·19	8·61	2·15	22·40	234·2	76·0
Improved Bancroft	15	15·72	0·25	3·00	18·97	1·24	22·40	138·5	48·1
G.B.–A.W.S.	15	13·45	0·25	2·62	16·32	1·10	17·92	119·1	51·4
Durango	6	4·80	0·19	0·31	5·30	0·88	11·64	96·5	68·0

TABLE VI.

ANALYSIS OF CAMBODIA AND BANCROFT RE-SELECTIONS.

Strain.	*Yield of Seed Cotton per Plant.*				*Mean Weight of Seed Cotton per Boll.*	*Mean Maximum Lint Length.*	*Ginning Percentage.*	*Lint Index.*	*Mean Weight of 100 Seeds.*	*Remarks.*
	First Picking (June 4, 1928.)	*Second Picking (July 18, 1928).*	*Third Picking (Aug. 27, 1928).*	*Totals.*						
	Gms.	Gms.	Gms.	Gms.	Gms.	Mms.		Gms.	Gms.	
G.C. 4/2 ..	90·0	23·0	3·4	116·4	8·5	30·5	34·8	7·50	13·98	Plant growth medium lax.
G.C. 4/5 ..	158·1	27·2	3·2	188·5	8·4	30·9	32·7	7·15	14·65	—
G.C. 6A/6 ..	135·9	—	5·5	141·4	8·5	29·5	37·0	7·19	12·23	Plant growth medium lax.
G.C. 7/1 ..	319·4	21·1	33·0	373·5	8·2	29·4	36·7	6·82	11·77	Plant growth medium lax.
G.C. 15/4 ..	200·1	50·3	6·4	256·8	7·0	29·4	32·5	6·26	12·99	Plant growth moderately compact.
B.C. 8/1 ..	179·3	28·8	—	208·1	9·5	29·2	37·5	9·23	15·34	Plant growth medium.
B.C. 8/7 ..	150·7	113·5	—	264·2	7·4	29·2	33·1	6·74	13·58	Plant growth medium lax.
B.C. 8/9 ..	107·2	—	—	107·2	7·2	32·4	33·5	6·68	13·22	Plant growth medium lax.
B.C. 8/2A ..	58·7	11·0	5·7	75·4	8·1	32·3	34·8	8·20	15·32	Plant growth medium, fairly compact.
B.C. 8/29/7 ..	70·8	69·9	70·3	211·0	6·4	30·5	34·6	6·92	13·05	Plant growth medium lax.
G.B. 0/1/1 ..	45·0	—	—	45·0	5·8	31·1	32·9	5·68	11·56	Plant small compact.
G.B. 0/2/8 ..	81·5	—	—	81·5	7·6	32·2	32·1	7·33	15·47	Plant small compact.

to be more homozygous than the bulk. Compactness and early maturity are important qualities for Southern Rhodesia, and for climatic reasons strong vegetative vigour, quite apart from possibly being indicative of marked heterozygosity, is not looked upon with favour.

All the Barberton seed showed very low germination. The germination on the multiplication plot was not more than 25 per cent., and the stand was further reduced in places by wireworm attack. After refilling with spare seed the ultimate stand, with single-seed planting, in the U.4 observation plots was only 42·5 per cent.; U. 4/5, 48·5 per cent.; U. 4/6, 48 per cent.; U. 4/4/7, 54·0 per cent.; and U. 4/4/8, 57·5 per cent. The stand on the adjoining plot of Durango was 85·0 per cent.

Altogether some 15 lbs. of U.4, U. 4/5, and U. 4/6 were used for multiplication, and a return of 3,539 lbs. of seed cotton was obtained. This was with a very poor stand and in an indifferent season; it must be granted, however, that the widely scattered U.4 plants did not feel the effects of the drought to nearly the same extent as the more closely spaced plots. The details of the yields are set out in Table VII.

TABLE VII.

YIELDS OF U.4.

	Picking Date.	*Yield (Lbs. of Seed Cotton).*	*Commercial Ginning Percentage.*	*Mean Weight of 100 Seeds.*
First Picking:				
Mixed Bulk	May 26 to June 2, 1928	2,047	30·2	9·78
Special Bulk	May 23-25, 1928	122·5	36·7	9·98
Rogued Out	May 1-22, 1928	206	—	—
Single-Plant Selections	May 24 to June 1, 1928	46	—	—
U. 4/5	June 4, 1928	83	—	9·20
U. 4/6	June 4, 1928	98	—	9·72
Second Picking:				
Mixed Bulk	July 3-6, 1928	366	32·0	9·62
Special Bulk	July 7, 1928	32·5	35·4	9·91
Single-Plant Selections	July 6-17, 1928	23	—	—
U. 4/5	July 6, 1928	6·5	—	—
U. 4/6	July 6, 1928	7·5	—	—
Third Picking:				
Mixed Bulk	August 27-30, 1928	415·5	—	—
Special Bulk	August 30, 1928	51	—	—
Single-Plant Selections	August 27, 1928	5·5	—	—
U. 4/5	August 30, 1928	19·5	—	—
U. 4/6	August 30, 1928	9·5	—	—

206 lbs. of seed cotton were picked from plants rogued out of U.4, U. 4/5, and U. 4/6 in May and June. Probably something over 10 per cent. of the plants were rogued out as showing insufficient jassid-resistance or distress from other causes. It would have been better if a larger roguing could have been made to ensure less splitting in crops from the distributed seed, but in view of the tremendous demand it appeared better to rogue out only this smaller amount and to multiply up a special bulk from mass selections of good quality, to replace in a year or two the first issue.

The extent of the second and third pickings is of great interest, as they matured during a period of low temperatures. Throughout the bolls opened well. The lint of the third picking tended to be soft, but the lint of the second picking was quite good cotton, and all the seed appeared to be sound.

In a more normal season the picking should not be so protracted. The February-March drought caused a break in the flowering, and a second crop was produced after the end of the March rains. This matured slowly under less favourable conditions than the earlier crop. A favourable February and March would probably have meant a heavier total crop, maturing quicker, and suitable for gathering in two pickings.

The much higher ginning percentages of the special bulk contrasted with that of the mixed bulk are interesting, and also the higher seed weights. The ginning percentages are the commercial ginning percentages of the bulks through the fifty-saw gin, and from the bulk seed twenty groups of a hundred seeds each were taken for each seed-weight estimation.

Bulk U.4 lint was forwarded to the Durban Central Co-operative Exchange, and was described by Mr. Hesse as good $1\frac{1}{8}$-inch nice cotton, hard and good in character, and in particular showing very good drag. It pulled very unevenly, indicating that there existed a strong mixture of long and short fibres. This unevenness is undoubtedly due partly to the heterogeneity of the bulk and partly to the season. With the season experienced and the wide scattering of the single plants (giving high single-plant yields) a certain lint variation to the single plant throughout the season is to be expected. Much of the unevenness will be remedied by the multiplication of the special bulk, which should at the same time give a longer staple and a heavier yield. The mean single-plant yield in the special bulk was more than $\frac{1}{2}$ lb. of seed cotton per plant.

Four U.4 samples and one A.12 sample of lint will be sent home for spinning tests and broker's opinion. The U.4 samples will be

from the bulk, first and second pickings; from the special bulk, first picking; and a composite sample of selected lint.

U.4 Single-Plant Selections.—One hundred and thirty-nine U.4 single-plant selections were made, of which only three were rejected after laboratory examination. Table VIII. gives the analyses of twenty-five of the more interesting.

The analyses showed the general quality to be extremely high; single-plant yields are very good; the lint lengths are excellent; ginning percentages and lint indices are high, and the seed cotton is uniform. All the selections are highly jassid-resistant; most of them are also early maturing. They are drought-resistant, and if some of them behave well under conditions of heavier rainfall some very excellent strains should be evolved.

The following are means for all the 136 U.4 selections retained:—Mean total plant yield is 242·6 gms. per plant, 148·8 gms. first picking, 75·4 gms. second picking, and 18·4 gms. third picking; the mean boll weight is 5·8 gms., the mean maximum lint length 32·8 mm., the mean ginning percentage 35·4 per cent., the mean lint index is 5·89, and the mean weight of a hundred seeds 10·68 gms.

Andrews 12.—A.12, though more jassid-resistant, did not prove to be so much at home as U.4. About 2¾ lbs. of seed were used for multiplication, and a yield of 417 lbs. of seed cotton was obtained. The stand was better than in the U.4 block. The first picking ginned out 34·4 per cent. The quality of the lint was very good. The seed from the multiplication block is being grown under an agreement next season. A season of heavier rainfall might suit it better.

Thirty single-plant selections have been retained, the analyses of eight of which are set out in Table IX.

Other Strains.—None of the other Barberton strains was so satisfactory as U.4 or even as A.12. They all showed good jassid-resistance, however; B.Z. 1/9 and B.B. 179 were fair, but did not crop very heavily. B.Z. 49/6 was squat and late, and B.Z. 106 did not give good results. Single-plant selections have been taken out of each of them for next season. Table X. gives the analyses for some of the more interesting.

Crosses.

Further crosses were made between two or three fairly compact Cambodia plants of moderate staple, and a few otherwise desirable plants showing insufficient resistance to jassid. Several of last season's crosses have been carried forward a further generation.

TABLE VIII.

ANALYSIS OF U.4 SELECTIONS.

Strain.	Weight of Seed Cotton per Plant.			Total.	Mean Weight Seed Cotton per Boll.	Mean Maximum Lint Length.	Ginning Percentage.	Lint Index.	Mean Weight of 100 Seeds
	First Picking (May 24 to June 1, 1928).	Second Picking (July 6-17, 1928).	Third Picking (August 27, 1928).						
	Gms.	Gms.	Gms.	Gms.	Gms.	Mms.		Gms.	Gms.
U. 4/40	392·0	62·4	—	454·4	5·6	33·4	36·9	6·05	10·33
U. 4/53	192·2	124·2	12·0	328·4	5·9	36·3	32·4	5·28	9·97
U. 4/62	244·2	44·9	11·4	300·5	5·5	34·7	34·4	5·71	10·87
U. 4/75	271·5	162·1	—	433·6	5·6	30·5	38·9	6·24	10·26
U. 4/76	257·5	167·5	21·1	446·1	6·8	33·4	35·6	6·37	11·51
U. 4/78	284·9	75·3	25·8	386·0	5·5	34·2	34·8	5·33	10·00
U. 4/80	122·8	177·2	31·2	331·2	5·8	34·1	33·9	5·66	11·00
U. 4/81	276·3	208·7	10·0	495·0	6·2	29·9	39·7	6·66	10·08
U. 4/83	152·4	236·1	19·0	407·5	6·1	32·2	36·4	5·86	10·24
U. 4/85	75·0	108·4	62·1	245·5	4·9	37·2	32·5	5·15	10·68
U. 4/91	145·3	206·5	115·5	467·3	6·4	36·5	31·2	5·51	12·15
U. 4/99	202·2	68·4	7·0	277·6	6·8	38·1	32·8	5·71	11·67
U. 4/103	260·0	77·2	12·6	349·8	6·3	32·2	36·6	6·61	11·45
U. 4/104	113·0	55·9	—	168·9	7·7	35·1	35·7	7·25	13·05
U. 4/107	105·7	187·6	76·9	370·2	6·4	37·2	32·7	5·88	12·08
U. 4/113	211·5	62·2	—	273·7	6·7	36·1	36·2	6·57	11·57
U. 4/117	317·0	79·0	14·1	410·1	6·4	33·8	39·0	6·69	10·44
U. 4/119	135·1	67·6	21·0	223·7	6·6	35·0	34·6	6·88	12·96
U. 4/123	135·0	44·8	16·3	196·1	6·5	37·4	33·4	6·35	12·62
U. 4/126	202·9	41·0	—	243·9	5·7	32·5	38·0	5·63	9·17
U. 4/128	137·5	31·3	—	168·8	5·8	36·4	35·2	5·79	10·67
U. 4/130	274·8	99·0	7·5	381·3	6·8	35·7	36·0	6·66	11·83
U. 4/132	112·6	175·5	14·1	302·2	5·5	35·7	39·2	5·91	9·15
U. 4/136	213·8	60·2	6·5	280·5	6·3	34·8	35·2	5·12	10·01
U. 4/137	117·5	6·5	—	124·0	6·0	35·0	37·6	6·06	9·99
Mean of 136 selections ..	148·8	75·4	18·4	242·6	5·8	32·8	35·4	5·89	10·68

TABLE IX.

ANALYSIS OF A. 12 SELECTIONS.

Strain.	*Weight of Seed Cotton per Plant.*			*Totals.*	*Mean Weight of Seed Cotton per Boll.*	*Mean Maximum Lint Length.*	*Ginning Percentage.*	*Lint Index.*	*Mean Weight of 100 Seeds.*
	First Picking (May 24, 1928).	*Second Picking (July 17, 1928).*	*Third Picking (August 27, 1928).*						
	Gms.	Gms.	Gms.	Gms.	Gms.	Mms.		Gms.	Gms.
A. 12/4	139·6	24·6	3·8	168·0	6·6	34·1	31·7	5·06	10·86
A. 12/10	194·7	34·0	22·6	251·3	8·0	33·7	34·9	5·54	10·33
A. 12/12	153·5	12·3	—	165·8	7·0	32·3	36·1	5·79	10·24
A. 12/13	102·1	33·0	—	135·1	6·4	31·7	34·1	5·70	10·99
A. 12/14	127·7	30·6	1·5	159·8	6·9	35·1	34·0	5·37	10.39
A. 12/17	134·5	22·9	—	157·4	6·9	30·8	34·2	5·28	10·14
A. 12/19	136·5	18·2	—	154·7	6·7	32·9	33·2	5·21	10·48
A. 12/30	142·7	27·1	—	169·8	6·9	32·2	33·1	5·57	11·25
Mean of 30 selections ..	111·2	19·3	11·9	142·4	6·4	32·7	32·7	5·32	10·9

On May 22 a very successful farmers' day was held on the station. About one hundred and twenty visitors from various districts in Southern Rhodesia were present. They were greatly heartened by the contrast between the behaviour of the resistant strains and that of the commercial stocks.

TABLE X.

Analysis of Selections from other Barberton Strains.

Strain.	*Weight of Seed Cotton per Plant.*			*Mean Weight Seed Cotton per Boll.*	*Mean Maximum Lint Length.*	*Ginning Per-centage.*	*Lint Index.*	*Mean Weight of 100 Seeds.*
	First Picking (May 31, 1928).	*Second Picking (July 17, 1928).*	*Totals.*					
	Gms.	Gms.	Gms.	Gms.	Mms.		Gms.	Gms.
B.B. 179/1	103·6	7·4	111·0	7·2	34·9	31·4	6·31	13·75
B.B. 179/2	84·2	30·9	115·1	7·1	35·4	32·1	6·84	14·44
B.B. 179/6	112·8	15·0	127·8	6·4	34·6	30·8	6·27	14·09
B.Z. 1/9/1	103·3	—	103·3	7·0	29·6	30·4	5·66	12·93
B.Z. 1/9/2	191·8	—	191·8	7·0	30·7	32·6	6·21	12·79
B.Z. 49/6/1	74·8	33·6	108·4	6·3	30·5	29·2	5·49	13·30

During the season the following members of the Cabinet visited the station:—The Hon. J. W. Downie, Minister of Mines and Public Work; Colonel the Hon. O. C. du Port, Minister of Agriculture and Lands; the Hon. P. D. L. Fynn, Minister of Finance; and Major the Hon. R. J. Hudson, Attorney-General and Minister of Defence.

It is a pleasure to acknowledge again the assistance rendered by Mr. A. H. McKinistry, who once more shared with the writer the work of the year.

APPENDIX A.

Rotation Crops.

During the season under review, a total of 47 acres was planted to cotton, 72 acres were under maize for grain and ensilage, 5 acres under ground nuts, and 10 acres under sunn hemp, which was ploughed in as a green manure; 21 acres of old land and about 70 acres of land which was broken up last year were fallowed.

U.4 Selection : Desirable Type.

U.4 Selection : Desirable Type.

Foreground: Durango. Highly Jassid Susceptible. Background: Cambodia, Jassid Immune.

Owing to the February-March drought the season was an unsatisfactory one for rotation crops. Maize was a partial failure, the mean yield for the station being 2·75 bags per acre, 550 lbs. per acre shelled maize, contrasted with approximately 11 bags per acre last year, and over 13 bags per acre the year before. The mean yield of ground nuts was 420 lbs. per acre.

The seed retained from three of the best maize ears of last year, a portion of each of which was planted ear to row this season, will be mixed and planted in a small plot this coming season. Ear-to-row work will be continued next season. Small plots of ground nuts from the selected plants will also be grown.

Seventeen barley strains and ninety-eight wheat strains were planted in small plots, but owing to the drought and white ant attack were a complete failure.

Now that the lay-out of the station is practically completed and newer land is becoming broken in, a crop-rotation system will be put into practice suited to the work that is being carried out. As no kraal manure is being applied, green crops will be ploughed in.

For the past two years the land which was to carry the main experimental cotton the following season has been fallowed; it has been ploughed for the second time, rolled and harrowed after the last heavy rains, to get as good a tilth as possible and at the same time to conserve the moisture for the early planting. In a wet season there is probably a loss of nitrates from the fallow land, and it has now been decided to grow a cover crop to be ploughed in, instead of having the land fallow. The same advantages of good early tilth and moisture conservation would be obtained. It is intended to try a light sowing of sunn hemp, ploughed in early. If this is not satisfactory, a non-leguminous cover crop will be tried. Maize will follow cotton, in some blocks for two years, in others probably for one. In the event of its being proposed to plant more cotton than there is fallow land, cotton will follow the first-planted maize. It is the practice of the station to accomplish as much ploughing as possible early in the winter, while there is still moisture in the soil, and at the same time by following the plough with roller and harrow to get as good an early tilth as possible, thus to conserve soil moisture and make the land available for early planting.

In July a preliminary soil survey of the station was carried out by the Chief Chemist of the Department of Agriculture; the details of this analysis will be available for next season.

ANGLO-EGYPTIAN SUDAN

REPORT ON THE WORK ON COTTON CARRIED OUT BY THE PLANT BREEDING SECTION, DEPARTMENT OF AGRICULTURE AND FORESTS, SEASON 1927-1928.*

BY

M. A. BAILEY.

PART I.—INTRODUCTORY

Staff.

Certain additions have taken place during the season under review.

Mr. F. E. Kenchington, who was originally attached to the Section for a year's course in October, 1926, has, on the expiration of that period, been appointed by the Empire Cotton Growing Corporation as Assistant Plant Breeder on a three years' contract.

A new post of Record Clerk has been approved and was filled by Mr. Howard, who was brought out from England for the purpose. He arrived on November 30 to take up his duties, but, unfortunately, ill-health made it necessary for him to return to England on February 1, so that the Section was not able to obtain much benefit from the appointment. Efforts are now being made to fill the vacancy caused by his retirement.

An additional post of Senior Plant Observer has been filled by the appointment of a boy who had recently passed out from the Gordon College, Khartoum, and the staff of the Section may now be considered to be sufficient for present purposes, unless further expansion of Variety Testing work into the Southern Provinces calls for additional Sudanese staff for the purpose of supervising the work there.

Buildings and Equipment.

The constructional work on the Experimental Farm at Shambat has now been completed by the addition of a range of buildings which give ample accommodation for the Sudanese staff engaged on the routine laboratory work in connection with the Cotton Breeding plots, and by the construction of two good-sized cotton and seed stores and a roomy shed for the working bulls and farm implements.

* May 1, 1927 to April 30, 1928.

The buildings are quite satisfactory for the purposes for which they are intended, and the Section may be considered fortunate in being so well housed.

The roller gin which was installed last year has worked satisfactorily, and the whole of the present season's crop, in addition to the carry-over from last year, has been ginned out. A power supply has been obtained by laying an electric cable across the Nile from Omdurman, and this also supplies lighting for the laboratories and staff houses.

In addition to the above buildings, a new house has been erected for the accommodation of the Assistant Plant Breeder, and ten others of various sizes, constructed with external walls of burnt brick, have now been completed for the Sudanese staff. These latter have replaced the original mud houses, which formerly served this purpose, but which had become, in the course of years, barely habitable. Two of these older houses still remain, and it is hoped to replace these at a later date if circumstances permit.

As regards the internal fittings and machinery, little now remains to be done except to complete the provision of apparatus for the laboratory. This will be done gradually in accordance with requirements.

The Experimental Farm.

An additional area of about $1\frac{1}{4}$ feddans has been taken over in an isolated position in the forage farm adjoining the Experimental Station. This area was used for the breeding and propagation of American cottons, the site being selected so as to avoid intercrossing with the long-staple varieties which occupy the farm proper.

As last year, two plots of 5 feddans each have been rented in the vicinity of the farm. One of these, situated at Kober, was used for a variety test plot for American cottons, and we are again indebted to the owner, Mr. Aziz Kfouri, for kindly supplying the water required for irrigation purposes. The other plot is situated in the heart of the Shambat Pump scheme, and is rented from native owners. It was used as the site for a test plot for Egyptian varieties, and may be taken as a fair sample of the conditions which obtain in the Shambat Pump area.

All these external plots were worked with labour, etc., from the central Research Farm.

As regards the farm itself, the general arrangement remains unchanged, except that a strip of land of varying width on the desert-side, which had proved to be unsatisfactory for the growing

of cotton and other field crops, has been handed over to the Forestry Section for the raising of trees, on the understanding that a certain proportion of the trees grown will be left *in situ* to form a permanent protective belt on that side.

The allocation of the farm land during the past season was as follows:

	Feddans (Exclusive of Outside Plots).
Cotton	20½
Dura	2
Berseem	10
Cowpeas	1
Wheat	2
Miscellaneous small crops	1½
Fallow	32
Trees, buildings, roads, etc.	20
Total	89

General.

The past season has been a satisfactory one in general, especially as regards the yields of cotton obtained on the Research Farm at Shambat, which much exceed those obtained in recent years, and that of last year in particular.

This improvement was, on the whole, shared by the various Pump Stations owned by the Government on the Nile north of Khartoum, but was not invariable as shown by the following Table:

Yields at Pumping Stations in Last Three Seasons Compared.
(Yields Given in Large Kantars* per Feddan.†)

	1925–26.	1926–27.	1927–28.
Shambat (Sakel cotton)	2·7	1·1	2·6
Gendettu (American cotton) ..	5·2	2·6	1·8
Kitiab „ „	4·5	3·3	2·9
Mikeilab „ „	4·7	3·3	3·3
Bonga „ „	3·7	2·1	3·6
Nuri „ „	5·1	3·8	4·1
Gureir „ „	3·3	3·2	4·6
Ghaba „ „	3·9	1·5	3·9

It will be seen from the Table that the yield of the Shambat Pump scheme returned to the level of 1925-26, which is about normal for the district. The recovery was, probably, largely due to the almost complete disappearance of the Sudan bollworm, which caused such heavy sheddings in the early stages of growth last year. First

* A large kantar=315 lbs. of seed cotton, containing approximately 100 lbs. of lint.

† A feddan=1 acre (very approximately).

pickings were, in consequence, taken earlier, and were very much heavier, as shown by the following figures:

SHAMBAT PUMP SCHEME. COMPARISON BETWEEN SEASONS 1926–27 AND 1927–28 AS REGARDS EARLY PORTION OF CROP.

	Date of First Picking.	*Total Amount Picked during December (in lbs.).*
1926–27.	December 22	9,350
1927–28.	December 10	29,500

On the Shambat Research Farm, the improvement was considerably greater than that noted on the adjoining Pump Scheme in general.

The *total* figures for the farm are valueless, in view of the large portions which are split up into small breeding plots with paths between.

The following, however, represent the yield from those plots of larger size in which a smaller proportion of unsown ground occurs:

Hosh. 4. Feddans 6 and 7	.. ..	Yield 4·1	large	kantars	per	feddan.
„ 9. Feddans 1 to 4	.. ..	„ 2·4	„	„	„	
„ 4. Feddans 2 and 3	.. ..	„ 3·2	„	„	„	
„ 10. (Area 7⅖ feddans)	.. ..	„ 3·0	„	„	„	
Average		„ 3·17	„	„	„	

Of the plots detailed, only the first was grown as a continuous block of cotton, under conditions comparable to that obtaining in field crops, and it will be seen that a yield of over 4 kantars was reached here. The average is reduced by the inclusion of Hosh 9, which contained a " dates of sowing " experiment, several sub-plots of which gave poor yields owing to their not being sown at the optimum date.

It is very reassuring to have obtained such satisfactory yields on the Experimental Farm this year, in view of doubts which have been expressed as to the suitability of the area for experimental purposes, having regard to the low yields in recent years.

The improvement over last year, when an average yield of only 1¼ kantars per feddan was obtained, is very striking. It is probable that it is in large measure due to the disappearance of the Sudan bollworm as a major pest. The excess yield over the rest of the Pump Station is no doubt partly due to an application of sulphate of ammonia (2 cwt. per acre) which was given about six weeks after sowing, but equally so to the systematic use of a ridging plough between the ridges of growing plants, sometimes, but not always, preceded by a horse-cultivator.

These implements are drawn by bulls, and it was found possible to continue their use until after the flowering stage had commenced, without materially damaging the plants. In the case of the 2 feddans in Hosh 4, where particularly high yields were obtained, five of these intercultivations were given, and hand-hoeing entirely dispensed with.

As regards climate, the season was chiefly remarkable for the abnormally high temperatures which prevailed throughout practically the whole period.

The accompanying Table summarizes the condition of temperature and humidity experienced, as compared with normal expectation. Normal figures are based on the record of the thirteen years previous to 1926. Rain fell in about the usual quantity during the summer months, mostly in heavy falls with dry intervals. The only occasions of importance were:

July 10	46 mms.
July 26. 27, and 30	46 „
August 6	28 „
August 30	24 „

	Maximum Temperature.	*Minimum Temperature.*	*Relative Humidity.*
1927. July ..	Round about normal.	Slightly below normal on the whole.	Somewhat above normal (round about 60).
August ..	Mostly about 3° above normal. Temperature only four times exceeded 40° C.		Rather subnormal.
September	About normal, except for one very subnormal day (30° C.) on the 13th.		About normal.
October ..	Without exception abnormally hot (about 4° above normal). Temperatures between 42° and 44° C. were recorded on 17 days in the month.	About normal.	
November	Varied from 1° to 4° above normal, except for a period of 9 days (5th to 13th).	Normal, except from 5th to 13th when ran a few degrees below.	Mostly rather above normal.
December	Whole month abnormally warm (generally 2° or 3° over normal).	About normal. No really low temperatures. 12° C. recorded on two occasions.	Decidedly drier than normal (mostly below 40).

	Maximum Temperature.	*Minimum Temperature.*	*Relative Humidity.*
1928. January ..	Whole month abnormally warm (often 5° or more degrees above), except for 3 cooler days round January 10.	Mostly well above normal. Only 2 days at all cold (12° C. on 2nd and 9·5° C. on 10th).	Mostly well above normal (round about 60).
February	Above normal for first 16 days, then slightly below for 3 days, rising again for a few days, after which a cold period set in (24th to 29th), which lasted into following month.	Course of events closely followed maximum temperatures. Only records below 12° C. were on 17th (11·5° C.) and on 26th (10° C.).	First part about normal. Last week much below normal (round about 25).
March ..	Cool weather continued for first 4 days, after which rest of month was very hot, except for a single very brief normal period (March 24). During hot period temperatures ranged about 5° above normal, and temperatures between 42° and 45° C. were recorded on 10 days.	Below normal for first 10 days, the coldest night of the year (9° C.) being recorded on March 2. Rest of month mostly well above normal.	Mostly well below normal. Some rain fell on 16th (very exceptional).
April ..	Except for 3 cool days (7th to 9th), practically whole month was slightly above normal, with specially high temperatures (44° to 46° C.) on the 5th, 17th, and 18th.	First half normal or rather below. Rest much above normal.	Mostly below normal.

It is apparent from the Table that the young plants began their development under conditions which were distinctly favourable. September, a critical month, was mostly round about normal, and, although August was hotter than usual, no excessively hot days had occurred.

By the end of September, the earlier buds were well on in their development and the plants as a whole were past the most sensitive stage and better able to resist the exceptionally hot conditions of the following month.

October and November, when flowering was at its height, were often very hot indeed, but a reasonable humidity prevailed throughout, which must have tended to neutralize any ill-effects.

Throughout the growing period the plants did well, with very

little early shedding compared to that which had occurred in the previous year. Shapely bushes, with long fruiting branches produced reasonably low down, were the result.

It is probable that the persistently high temperatures of the winter and early spring months, combined with the low humidity often experienced, contributed to the difficulty which some varieties had in opening their bolls in a normal manner.

On the whole, the season at Shambat was decidedly more favourable, climatically, than the previous one.

PART II.—EXPERIMENTAL WORK, ETC.

1. Inspection of Cotton Areas.

No new ground has been traversed during the course of the past season, but visits were made by Messrs. King and Kenchington to Fung Province, and by the former to Nuba Mountains Province for the purpose of inspecting the Variety Tests established in those districts.

Cotton-growing in Fung Province has declined even below last year's level, and the total crop got in from that Province has amounted to only about 250 large kantars. The two plots at Sabonabi and Ghati gave a mean yield on gross area of only 235 lbs. seed cotton per acre, though some 30 inches of rain fell during the season. The effect of the extra care which had been given to the sowing and cultivation of these plots was clearly seen when a comparison was made with the neighbouring patches of native-grown cotton. It is apparent that this is about the minimum rainfall on which cotton can be grown on soil of this type, and the choice of situation of the experimental plots may be considered to be satisfactory as allowing of observation of the behaviour of the varieties under minimum rainfall conditions.

With the opening up of the Gedaref district by railway in the near future a considerable new area, with rather similar conditions of rainfall and soil, will be rendered readily accessible, and, in view of the difficulty in reaching the cotton lands in Fung Province during the wet season, it will probably be advisable to transfer our test plots to the former district when the next season's work has been completed.

Cotton-growing in the Nuba Mountains Province has continued to increase rapidly, and over 13,000 large kantars were obtained there in the past season. Our two experimental plots in that region both

did very well, and the yields obtained (round about 900 lbs. seed cotton per acre) demonstrate the possibilities of the district. The plots appeared to be well sited from the point of view of their being representative of the surrounding conditions of soil and climate.

A visit paid to the Gezira area in early January was interesting, as affording a contrast in the behaviour of the plants with that of the previous season. The plants were noticeably " hollow " below, due to shedding of fruiting branches and bolls which had occurred in the early stages, presumably owing to Blackarm, which disease had been decidedly more active this season during late September and October. Close observations made in the variety test plot at the Gezira Research Farm showed that, in this locality at any rate, the formation of fruiting branches had begun at about the same node of the stem as last year (10th to 11th stem axil), and that in a few cases a single odd boll had set quite low down, but the increasing intensity of Blackarm attack had denuded the stems or branches, where formed, for four or five nodes above this point. At Barakat the disease developed earlier and the trees were more uniformly blank below.

Another point of interest to which attention was drawn at Wad Medani and Barakat was the very large numbers of cases, amounting often to 30 per cent. of the plants, in which the main axis had been destroyed at some time fairly early on in October by an insect which had eaten out the growing point. This natural pruning must have had a somewhat comparable effect to the more drastic artificial topping of the plants which was tried experimentally at Shambat this year, and which was found to cause a considerable diminution in yield. The condition was very marked at both Wad Medani and Barakat and was presumably more or less widespread.

2. Selection, Line-Breeding and Hybridization.

Work has been continued on the lines indicated in previous reports. The total number of families of single-plant origin which were dealt with amounted to about 280, which was of the same order as in the previous season.

It has, however, been found possible to extend considerably the routine of flower-selfing, owing to certain improvements in methods and to the added familiarity of the staff with the work.

Flowers are protected from accidental cross-fertilization by pulling over the almost mature buds small bags of fine-mesh mosquito netting, which are then closed at the base of the buds by a single turn of soft wire. The bags are left in position for two days following the

opening of the flower and are then removed, boiled to kill any adherent pollen, after which they can be used again.

We had previously employed for this purpose narrow cylindrical bags, which, though easily applied when new, were found to be difficult to pull over the buds after they had shrunk as the result of a few boilings. This difficulty has been entirely overcome in the present season by employing cone-shaped bags, 10 cms. long and 6 cms. wide at the open base.

Bags of this shape can be put on just as rapidly after they have shrunk as when they were first made, and the saving of time in consequence was considerable. Soft aluminium wire was found to be very easy to manipulate and proved to be entirely satisfactory for closing the bags, and at the same time the risk of breaking the flower stems was reduced owing to its lightness.

The bag is pulled right down over the bud, so that the petals forming the bud-cone are quite unable to expand, and the protection given to the stigma is complete.

With this improved form of selfing-net it was found possible, working with a squad of six to eight boys, to deal with 40,000 flowers during the season. We are thus assured of an adequate supply of self-bred seed for the coming year.

Types of cotton suitable for the irrigated tracts of the Northern Sudan and others for the Southern rain-zone are both being dealt with at this station.

Selections from the following kinds of cotton were grown here during the past season:

American	37	" New Selection " families, and 52 " Pedigree Line " families.						
Sakel	18	"	"	"	4	"	"	"
Upper Egyptian	13	"	"	"	20	"	"	"
Sea Island	35	"	"	"	55	"	"	"
Others	3	"	"	"	3	"	"	"

(*a*) *Egyptian and Sea-Island Families.*—It will be noted from the list given above that comparatively few Sakel selections were dealt with. This is due to the fact that all the Sakel types so far seen here show the same unsatisfactory characteristics as regards habit of growth, and it is felt that more hope lies in combining the excellent habit and notable vegetative vigour shown by some of the many types of Sea Island with Sakel quality and character of lint, than in making an extended search for better plants amongst the Sakel population of the country.

None of the selected Sakel families this year gave encouraging results, and the number carried on next year will be still further reduced.

Some of the Upper-Egyptian selections gave satisfactory yields,

but, as a type, they appear to have a very strong tendency towards "lodging" in this country, and are usually severely attacked by Blackarm. Certain of the families this year showed evidence of splitting, and in some cases the lints were of very superior quality. It is possible that these forms may be fixable and may give useful results.

The Sea Island families grown this year represented only the most "likely" of the large range of types, with which Mr. Burd so kindly supplied this Section in 1925. Many of the families left nothing to be desired in the matter of habit, vegetative vigour and boll production. Until a late stage the plants were rigidly upright, in marked contrast to the badly-lodged Sakels alongside, and the long, symmetrically-borne fruiting branches were produced low down and were covered with bolls. The foliage also appears to be definitely more heat-resistant than is the case with Sakel cotton.

Grown at Shambat, these particular strains of Sea Island begin to open their bolls about a week later than Sakel plants alongside; but owing to the much slighter tendency to shed in the lower fruit-bearing zone the number of bolls opened in, say, the first three weeks, is, roughly speaking, the same, the period required for boll-maturation being very similar in the two cases.

These Sea Island types appear to be rather more resistant to Blackarm than Sakel, and this also conduces to a comparatively heavy mid-early crop.

The potential total crop, based on the number of green bolls produced, in these Sea Island strains is, in some cases, twice or three times that of Sakel.

It is clear that some types of Sea Island offer very valuable possibilities in the direction of improving the long staple cotton grown in this country; but whether it will be possible to make use of certain selected strains in their present *modified* form, or whether it will only be possible to obtain a satisfactory product by crossing with other cottons, is still uncertain.

In the matter of staple, the cotton produced by the strains which are now being tried out here is practically unrecognizable as Sea Island, but this is clearly an advantage, as several of them approach Sakel in character and length of lint, though lighter in colour and with a satisfactory lustre—a feature markedly wanting in the majority of Sudan-grown Sakels.

The chief drawbacks at present encountered with these types are their generally low ginning-outturn and lint-index values, and, more particularly, the tendency found amongst all of them for their bolls to open badly.

The cause of this bad opening has yet to be determined with certainty, and experiments, in which insects will be rigorously excluded, will be carried out in the coming season.

Detailed observations were made in the past year on a number of bolls which were followed up from the opening of the flower-bud onwards, but the evidence is not sufficiently clear owing to the fact that the ripening period coincided with a wave of decidedly heavy Pink Bollworm infection, and the majority of the bolls were to some extent damaged, thus obscuring the issue.

The indications are, however, in favour of this bad opening being brought about by physiological factors apart from insect damage, though there can be no doubt that the gravity of the condition is much increased in cases where the contents of the locks have been partly destroyed by bollworms.

Sakel bolls were similarly examined throughout their development, with a view to obtaining information of a comparative nature. The following points of interest were brought out in this comparison and will be very briefly described.

Locks of both Sakel and Sea Island bolls are frequently found to contain less than their full complement of seeds, and, further, quite a high proportion of the seeds never get beyond the initial stages of development. These " blind " seeds are usually of very small size and covered with short fuzz, greenish or brownish in colour. They constitute one form of neppiness in raw cotton and have occurred with exceptional frequency during the present season.

It cannot be stated with certainty that these blind seeds are due to lack of fertilization, as several cases were observed where single locules contained only one or two seeds, or, in some cases, none, but in which the missing seeds were not necessarily represented by blind seeds of the type under consideration.

The following summary, based only on locks unaffected by bollworm or other diseases, will serve to illustrate this point and to show that the Sea Island types show much more tendency towards deficiency in the *total* number of developed or partly-developed seeds.

	Number of Healthy Locks Examined.	*Total of Healthy Seeds.*	*Average Number of Healthy Seeds per Lock.*	*Total of Blind Seeds.*	*Average Number of Blind Seeds per Lock.*	*Average Total of Blind and Healthy Seeds per Lock.*
Sakel	19	88	4·6	31	1·6	6·2
Sea Island ..	22	64	2·9	35	1·6	4·5

Entire failure to develop individual seeds may almost certainly be attributed to lack of fertilization, and the suggestion that Sea Island in this country is particularly liable to this deficiency is interesting, in that it agrees with a similar occurrence which has been reported in the case of exotic varieties of cotton grown in the Punjab.

Apart from this abnormality, cases were found both in Sakel and Sea Island where the interior of the seed was shrunken, sometimes almost to nothing, though the seed coat was intact and apparently normal and the lint of full length, though usually very tender. Several cases of this were met with in Sea Islands, but only one case in a Sakel plant.

The valves of Sakel bolls, except in cases of very heavy bollworm infection, usually open flat or are even slightly recurved. Those of the Sea Island strains grown here rarely open quite flat and, more frequently, fail to pass a stage which may be described as "half-open." The lint in such cases is often very soft, but not invariably so. Some cases were noted in which it was practically certain that the phenomenon was not due to insect damage.

A curious feature noted frequently in the case of Sea Island bolls, but not, so far, in Sakel, is the shrinkage in volume of the whole boll during the last two weeks of development. The diameter of many bolls decreases by as much as 15 per cent., or even more, during this period.

It is possible that this shrinkage is due to normal drying-out of the tissues, but that in the case of Sea Island bolls the deficiency of seeds, and also the low proportion by volume of lint within the bolls, offers less resistance to the forces of contraction than in the case of Sakel.

This preliminary contraction and falling-in of the sides of the locules might very well interfere with the normal rolling back of the valves when dehiscence occurs.

Purple discoloration of the boll surface is very common in these Sea Island bolls, but this would appear to be connected generally with the presence of bollworm. A similar occurrence is met with, but less frequently, in Sakel.

The different strains of Sea Island which are being tried out here are not all equally bad in respect of boll opening, and individual plants show considerable differences. The strains which were originally imported as AN 25.25 and GX 12.25.32, particularly the latter, are the most promising.

Selection is being directed largely to this point, and improvement is considered to be probable.

The other bad feature of these strains—their low ginning percentage—is also receiving attention.

This low outturn is characteristic of the type, but might well be more than offset by the increased yield of seed-cotton which might be obtained. Here, again, certain strains and individuals seem to be better performers than others, and advantage is being taken of this fact in our selection work.

In general, it may be stated that the ginning percentages of single plants in the Sea Island breeding plots varied between 21 and 30 per cent., whilst those of Sakel plants grown under similar conditions gave values of from about 30 to 34 per cent.

(*b*) *American Families.*—Attention in the case of the American cotton types is being concentrated chiefly on obtaining a high-yielding type, with high ginning outturn and with rather long staple, likely to command a premium which will help to offset the very high transport costs which are inevitable where the lines of communication are so extended.

The new selections which have been made here from the local strain of cotton known as " Pump Scheme Cotton " have proved very interesting, both on account of the very wide differences between types and owing to the very general tendency for these selections to breed true for a number of their distinguishing characters. Several of these selected types have given indications of very high-yielding power, but lints come out mostly between 28 and 32 millimetres (halo-length), which is rather lower than the length aimed at. No less than five families of this origin were sufficiently pure to enable them to be promoted to the " Pedigree Line " plot, and eight other plants have been re-selected for a new start in the " New Selection " plot next year.

In addition to these " Pump Scheme Strain " derivatives, certain off-type selections from other varieties were grown and recorded in detail. One family, raised from a selected Meade plant, gave results indicating a close approach to purity, and will be further propagated from. Fresh selections were also made.

The attempt made last year to select plants of the Pedigree Dixie variety, which would be free from the objectionable habit of lodging which is very marked in this type, has proved successful, and two families were obtained which were nearly pure for erectness. One of these families also gave very high yields and the lint lengths all ran high, but the family was clearly segregating in this and other characters and further selection and self-breeding will be necessary.

In the American Pedigree Line plot the following varieties were dealt with:

Delta Webber.
Columbia.
Meade.
Hanik (ex " Pump Scheme ").
Gendettu (ex " Pump Scheme ").
Pedigree Webber.
Pedigree Dixie.
Lighting Express.
Acala.
Durango.
Lone Star.

In the matter of purity all of these selected types gave satisfactory results, except the Columbias and Meades, which for the most part were found to be splitting freely. Further attempts will be made to fix these.

Some of the selected races which had been obtained at this Station from the Delta Webber variety proved very satisfactory in the matter of erectness, to which special attention had been paid as the ordinary field-crop lodges badly. Most of the families from this were very pure, and one of the best of these as regards yield and erectness, and length and quality of lint, is being taken on in bulk next year, with the idea of multiplying-up a supply of seed for distribution.

Several others will be carried on in the Pedigree Line plots, and a number of new selections have been made for erectness.

Other types which gave results of note included a selection, named " Hanik " (originally made by Mr. Massey from Pump Scheme Cotton), which gave very high yields, and a series of familiesd erived by selection from Lone Star, which gave consistently big yields, though the staple is rather wanting in length for our purposes.

Neither Acala nor Durango behaved in a satisfactory manner in the breeding plots, the latter being apparently affected by some disease which caused a very large number of buds to shrivel up on the stems.

All the types grown in the Pedigree Line plot, with the exception of the specially selected Delta Webber strains mentioned above, lodged badly, the condition of the land, which had lately been under a " permanent " leguminous crop, being probably a predisposing factor.

The plot as a whole gave very satisfactory growth and yields, and, as in the case of the separate plot devoted to Egyptian and Sea Island families, excellent returns of both self-bred and natural seed have been obtained.

(c) *Hybrid Families.*—Thirty-eight families of the F.5 generation from a Sakel by Sea Island cross were raised, certain plants selfed, and further selections made. A few families were found to be breeding approximately true, including a type with unusually dark brown lint. The appearance of lints of this type is quite frequent amongst the derivatives of this cross, and it is hoped to follow-up the method of inheritance.

Many of the families showed an improvement on Sakel in the matter of plant habit and fruitfulness, but the tendency towards the bad boll-opening, characteristic of the original Sea Island parent, was frequently evident, though in varying degree. As regards quality of lint the types now growing cover a very wide range indeed, but staples are mostly on the long side.

Eight small F.1 families from a first cross between Sea Island and Upper Egyptian types were raised and a good quantity of self-bred seed obtained.

Records were made on the character of the F.1 plants as compared with the parents, and further indications as to the mode of inheritance of certain characters may be obtained in the succeeding generation, which will be sown next season.

Some of the parents used in this latter series of crosses were found, on examination of their progeny this year, to have been impure, and the crosses made with these plants will be eliminated in subsequent studies.

Altogether, seed for sowing forty-five families (F.6 and F.2) has been reserved for propagation in the coming season.

3. Propagation.

Small nucleus areas, similar to those described last year, have been kept going, and it has been found possible to extend considerably the amount of flower-selfing work in these areas.

The types grown were as follows:

American.	*Egyptian.*	*Long Staple Exotics.*
Columbia 40	Sakel, Bolland 8	S.I.D.1·8.
„ 43	„ „ 19·3	S.I.D. 3·2.
„ 44	„ No. 186	S.I.D. 14·1.
Webber 38	Nahdah	
Pedigree Dixie	N.T. 25/24	
Meade (E.C.G.C.)	Garofallou	
„ (B.P.I.)		

Records were kept in all cases of yield, ginning out-turn, seed weight, and boll-maturation period.

In addition, certain isolated portions of the experimental farm

were set aside for seed production on a larger scale of the type referred to in last year's report as "Massey's Selected Domains" Sakel. This is an exceptionally strong cotton, though rather lacking in fineness.

Sufficient seed of this has been produced to sow the main crop of the farm next season and, in addition, the 20-feddan Roguing Plot, which is situated in the centre of the main Pumping Scheme area of Shambat and which supplies the seed for that area.

Where selfing operations were carried out, as in the smaller propagation plots referred to above, it has been possible to obtain figures for the proportion of opened flowers which succeed in reaching the ripe-boll stage. These figures, which were based on something in the neighbourhood of 1,000 flowers in each case, should be fairly reliable and should give an indication of the amount of boll shedding which has taken place here during the last season.

The results show that such shedding was much heavier amongst the American than amongst the Egyptian types.

The following gives, approximately, the range of percentages of bolls coming through to maturity in the different groups:

Lower Egyptian	24 to 60 per cent. (mostly over 40 per cent.).
Upper Egyptian	About 57 „
Long Staple Exotics ..	40 to 52 „
American	20 to 28 „

The boll shedding indicated represents, of course, all that due to insect and fungus attack as well as to "natural causes."

4. Cotton Variety Testing.

The policy, which was laid down at the start, of developing a comprehensive system of Variety Test Stations has been adhered to, and considerable progress made towards obtaining reliable results. The number of stations has not been increased this year, it being considered desirable to devote all available time to standardization of methods and to improvements in technique.

The following plots were laid down this season:

(A) Egyptian and Allied Types of Cotton.

I. Preliminary Variety Test (Irrigated).

Experimental Farm, Shambat.

II. Standard Test Series (Irrigated).

(i.) Shambat Pumping Scheme.
(ii.) Wad Medani (Gezira Research Farm).
(iii.) Barakat (Sudan Plantations Syndicate Seed Farm).

} Gezira tract

(B) American Types of Cotton.

1. *Standard Test Series (Irrigated).*

(i.) Shendi (Karu soil).	On Gendettu Pumping Scheme.
(ii.) Moeis (New river soil).	
(iii.) Kober (Karu soil).	On estate of Mr. Aziz Kfouri, near Khartoum.

2. *Standard Test Series (Rain-Grown).*

(i.) Talodi.	Nuba Mountains Province.
(ii.) Kadugli.	
(iii.) Sabonabi es Sherig.	Fung Province.
(iv.) Ghati.	

The only alteration as compared with last year's arrangement lies in the substitution of Sabonabi and Ghati for the two sites close to Singa (Fung Province) which had proved a failure in the previous season owing to lack of rain.

As now placed, the two plots in Fung Province represent fairly well the conditions likely to be met in growing cotton on black cotton-soil on a rainfall of about 25 to 30 inches.

The two test plots, which are situated at Talodi and Kadugli respectively, represent similar conditions as regards rainfall, but here the soil is much more loamy in character and overlies a subsoil of weathered rock. These plots may be taken as representative of the better cotton lands of the Nuba Mountains Province.

The remaining American cotton test plots are sited on different types of soil in the practically rainless area north of Khartoum. They constitute a fair sample of the conditions obtaining in the areas of cotton situated along the banks of the Nile and irrigated by water pumped from the river.

This district grows about 12,000 feddans of cotton annually, but is of considerable extrinsic value as constituting an area capable of close control where the propagation of pure seed can be carried on.

As yet it has not been possible to institute any variety test plots in the heavy-rainfall area in the extreme south of the Sudan. It is hoped to do this as soon as circumstances permit.

As regards the Egyptian cotton plot series, two of these are situated in the heart of the important Gezira tract, the third being close to the farm of the Plant Breeding Section at Shambat, where it constitutes an intermediary between the conditions at the Breeding Station and those in the Gezira.

As last year, we are much indebted to Mr. Aziz Kfouri and to the Sudan Plantations Syndicate for allowing us to use their land for

experimental plots, and to the Chief Inspector, Gezira Research Farm, and to the several Inspectors of Agriculture who have so kindly prepared the plots for us in many cases and assisted with supervision and arrangements for picking.

All plots in irrigated districts were laid out to cover an area of 5 feddans, those in the less accessible rain areas being 3 feddans only.

The general type of layout originally adopted, consisting of rows of long narrow strips in which the varieties are repeated five times in varying order, has been found to be very satisfactory, and has been adhered to.

Several improvements in technique have been introduced as the result of experience gained in last season's work and have assisted materially in obtaining satisfactory results.

Amongst these may be mentioned a system of laying out the ridges in irrigated plots so that they are parallel to the length of the narrow variety strips, and, in the Rain Zone, various methods for ensuring the correct spacing of the plants when sowing has to be carried out with entirely raw black labour. Both these innovations have been a success where they have been tried. The change in the direction of the ridges, though contrary to the usual ideas of field irrigation, has been found to offer no difficulties in the application of water and has made it possible to obtain much greater accuracy in sowing and picking as well as facilitating very much all inter-cultivation operations.

In all cases the first and last strip-plots of the Variety Test Plots have been sown as "protective belts," thus ensuring that all the varieties which are growing in the interior of the plot experience an exactly equal amount of edge effect.

These belts have in some cases been used for rough, tentative trials of new types of cotton or methods of growing the plants. The results obtained may for convenience be summarized here, as they do not necessarily apply to the type of cotton grown within the Variety tests enclosed by the belts:

(*a*) One of the belt strips at each of the rain-grown plots at Talodi, Sabonabi and Ghati was sown with Sakel. At Talodi an excellent stand was obtained and the variety grew quite strongly, but it shed very heavily indeed, especially in the early stages, and was much more severely attacked by Blackarm than the American varieties alongside. It was nearly a month later than the American varieties in giving any pickable quantity of cotton, and the total yield was not more than one-sixth of that of the lowest yielding bed of American cotton in the plot.

At Sabonabi the stand of plants obtained with this variety was so poor that the yield obtained was negligible, and at Ghati, though a half-stand was obtained, it failed to give any appreciable yield.

(*b*) The other belt at the Talodi plot was sown with another Egyptian variety, called Nahdah, which gave somewhat better results than the Sakel, but was almost equally affected by shedding and Blackarm. The yield obtained from this bed was less than one-third that obtained from the lowest-yielding American variety in the plot.

Rough as these tests are, the results are so strikingly behind those obtained with American varieties, that the deduction may fairly be made that Sakel and Nahdah are definitely unsuited to the rain-area in general. This is in accordance with expectation, in view of experience elsewhere.

(*c*) A new strain of Columbia cotton (Columbia No. 43) was tried out in the remaining belt-beds at Sabonabi and Ghati. The yield from these beds in neither case reached that of any other bed in the plot, which included the related strain Columbia 40. The conditions of stand and soil were satisfactory, and the indications of inferiority in yielding power thus obtained, though not conclusive, will be taken as sufficient grounds for not spending further time in testing out Columbia 43.

(*d*) Close-spacing tests were carried out in the belt-beds at Shendi, Moeis, Kober and Shambat.

Here again the results must be taken with the greatest reserve in view of the lack of replications of the spacings tried.

It seems pretty clear, however, from a comparison between the yields from the close-spaced belt-strips and the most nearly adjacent strips at normal spacing that the results depended primarily on the nature of the soil at the particular locality in question.

The results and possible deductions are summarized below as briefly as possible:

Kober (American varieties. Normal spacing=90×45 cms.).

The distance between holes containing plants in both belt-beds was half normal (*i.e.*, 90×22½ cms.).

The whole plot lacked vigour, the plants for the most part never growing together sufficiently to cover the ground.

Under these conditions the closer spaced belt-beds appeared to do better, the improvement being more marked at the end of the plot where growth in general was poorest.

Shendi (American varieties. Normal spacing=90×45 cms.).

Here the spacing of the belt-beds was only 50 per cent. closer

than in the rest of the plot. The general vigour was rather high, but tailed off towards the far end of the plot. Close spacing here appeared to result in a decided loss, the loss being more apparent at the most vigorous end of the plot.

Moeis (American varieties. Normal spacing=90×90 cms.).

A very vigorous plot as a whole, increasing in vigour towards the end of the plot. Belt-beds were grown at half distance (90×45 cms.). Belt-bed No. 1 was decidedly below the average of the plot as regards vigour; here an increase in crop was obtained from close spacing, but at the other end, in belt-bed No. 26, where growth was rank, a decided drop in yield was recorded.

Shambat (Egyptian varieties. Normal spacing=90×45 cms.).

Here belt-bed No. 1 was grown at 22½ cms. between holes, whilst belt-bed No. 32, at the other end of the plot, was thinned to the normal spacing between holes, but 3 instead of 2 plants were left in each hole.

The indications in this case were that the spacing in bed No. 1 gave a very much increased yield in the first picking, but a lower total yield, whereas the arrangement in bed No. 32 gave a normal first picking and possibly a somewhat higher total yield.

The results obtained from the Variety Tests themselves are detailed in the pages which follow.

It is, of course, necessary to note that high yielding power is not in itself sufficient to justify the growing of any one particular variety. The question of value per unit produced is equally important. This matter is gone into later in the section devoted to Graders' and Spinning Tests.

A. (*I.*) Preliminary Variety Test (Irrigated).

The plot employed for this test is situated on the Experimental Farm at Shambat. The varieties tried are not yet in general cultivation except one, "Massey's Selected Domains," which was included as a basis of comparison for the other types.

All the varieties come within the Egyptian Long Staple class except NT. 25/24, which is of Upper Egyptian type.

The soil fertility within the plot showed a slight decrease from west to east, but the distribution of areas of high and low fertility was irregular, and it is probable that no variety was severely penalized by the lie of the land in this respect.

An excellent stand was obtained, no resowing being necessary, and no other accidental circumstances occurred which would be likely to vitiate the results, which may therefore be taken as being quite reliable for the particular field and season to which they refer.

The plot was sown on August 8, and was manured with Sulphate of Ammonia (2 cwt. per acre) about six weeks after sowing.

A satisfactory yield was obtained, the net total yield from the "control" variety (Massey's Selected Domains) being just over 4 large kantars per feddan.

Final yield results are summarized in the following Table, the varieties being arranged in descending order.

PRELIMINARY VARIETY TEST. SHAMBAT EXPERIMENTAL FARM.

Varieties.	*Mean Bed Yield in Rottles.*	*Standard Error of Mean Difference.*	*Corrected Mean Bed Yields.*
Garofallou	213·6		211·8
N.T. 25/24	207·0		205·2
Massey's Selected Domains	188·0		188·4
S.I.D. 3·2	187·2	10·0	186·8
S.I.A. 2·7	185·4		184·8
S.I.D. 14·1	180·4		178·4
S.I.D. 18	178·2		178·8

Judged on the uncorrected mean bed yields, on the basis of the standard error of mean difference, Garofallou has a significant lead on all other varieties except NT 25/24, and the latter is probably significantly higher than the remainder.

The other five varieties are too close in their results to be separated.

The data obtained for the serial yields of consecutive beds enable us to attempt certain corrections for soil irregularities. These corrections are shown in the last column of the Table. It will be seen that the only appreciable effect of this has been to bring the last varieties closer together.

As regards individual performance, NT 25/24 was much earlier than the others, and led very easily in yield up to the third picking (end of January), but later pickings of this variety were well below the rest in quantity.

Garofallou and Massey's Selected Domains were the two slowest in commencing to flower, and in consequence were a trifle behind the rest in the first picking. They owe their position at the top of the list chiefly to the comparatively high yields which they gave towards the end of the picking season, though Garofallou also did well in the middle pickings.

As the high late yields of these two varieties were not foreshadowed in the flowering curves, it may be taken that their superiority lay in their ability to form bolls from flowers actually produced.

An examination of early flowering curves in conjunction with the yield curves to which they refer suggests that Garofallou is particularly successful in maturing its flowers at all stages, whereas NT 25/24 shows a very considerable discrepancy between flowering and bolling in the early stages, which can only be due to boll-shedding. NT 25/24 matures quicker than the others, as shown by the greater resemblance of the October 25 flowering curve to the December yield curve rather than to that of January. Of the "S.I." varieties, S.I. A.2.7 appeared to show a somewhat higher proportion of bolls to flowers than the others.

The following values, based on the third pickings only, in each case, were obtained this year for the ginning out-turn of these varieties:

	Per Cent.
S.I.A. 2·7	30·8
N.T. 25/24	30·1
Massey's Selected Domains	29·8
S.I.D. 3·2	29·6
S.I.D. 14·1	28·6
Garofallou	28·5
S.I.D. 18	27·8

This year's yield results bear practically no relation to those of last year, except in so far that NT 25/24 occupied a high position in both. This difference may be accidental, but is more likely due to the difference in the conditions under which the crop was grown, as shown by the fact that the average yield this year was more than three times as great as that of last year. The same varieties will be tried out again in the coming season in order to clear up this question.

A. (*II.*) Egyptian, etc., Varieties. Standard Test Series (Irrigated).

(i.) Shambat Pumping Scheme (sown August 9).
(ii.) Wad Medani (sown August 26).
(iii.) Barakat (sown August 29—beds 1 to 17; September 2—beds 18 to 32).

All the three plots in this series gave satisfactory results, the soil being sufficiently regular and the stand of plants sufficiently good to cause relatively slight errors.

At Shambat the stand, by actual count, was found to vary between 95 and 99 per cent. of full stand. At Wad Medani the range was between 84 and 96 per cent. In both cases the influence of deficiencies in stand could be traced in the yields given by first pickings from individual beds, but even at Wad Medani this effect did not,

in sum, amount to more than 2 or 3 rottles difference and could not be detected in later pickings. At Barakat no actual "count" was available, but germination was reported as being very good and very little resowing was necessary. A rough estimation of stand, made rather late in the season at this plot, suggests that in some beds irregularities in stand were reflected in yield, but the evidence is not sufficiently clear to allow of any corrections being attempted.

Weeds had, apparently, very little differential effect on yield. At Shambat they never became bad. At Wad Medani a considerable part of the plot became heavily infested by the first week in September, and the vigour of the plants in the area affected was clearly reduced, as shown by the detailed records made at that time. Fortunately, the weedy area corresponded fairly closely with two complete "blocks," containing all the varieties, so that the relative effect on yield was probably slight.

Blackarm occurred in all three plots, but the attack at Shambat was only slight. At Wad Medani and Barakat, on the other hand, the infection was heavy and caused a very appreciable loss of crop in the early stages.

At Barakat the sowing was interrupted by rain and followed by very heavy rain in the space of a few days. Blackarm was reported as abundant shortly after sowing, especially in the beds where sowing had been delayed with the effect of bringing the sowing date nearer to the incidence of the heavy rain. In this plot the plants made very poor growth until the last week in October, when they began to recover. Blackarm diminished in intensity very much during November, and by early January the plants were green and healthy, but rather bare below as the result of early shedding due to the disease.

At Wad Medani the Blackarm attack did not develop so rapidly, and a count of infected holes made on September 27 showed roughly only 2 to 7 per cent. of holes infected. By early October, however, all holes were affected, and the attack was definitely bad. It had ceased to increase by the third week in October, recrudesced during early November, and then gradually decreased and practically disappeared. It caused much defoliation and early shedding.

This difference in earliness of attack at Barakat and Wad Medani showed its effect later in counts which were made in January to ascertain the nodal position of the lowest sympodium at the two places. At Wad Medani, the first sympodium was found to have been held at about one node lower down the stem than at Barakat. This better start at Wad Medani was not, however, of much use to the

plants, for, though an occasional boll managed to reach maturity on these lowest sympodia of all, the zone immediately above showed almost complete shedding as the result of the Blackarm attack which developed later.

The data relating to the incidence of Blackarm on varieties are not so clear as was the case last year with the same varieties, owing to the fact that some doubt attaches to the figures obtained from a late estimation made at Wad Medani.

Estimations of the severity of infection were made at different times on the different plots, but, except in the case of the early count of infected holes made at Wad Medani, the examinations were made at a time when the disease had reached a quiescent stage, old lesions only being visible.

The results are given in the following Table, omitting the doubtful figures for the late count at Wad Medani.

ORDER OF SUSCEPTIBILITY TO BLACKARM IN THE EGYPTIAN VARIETY TESTS.

	Shambat (*Recorded December* 8).	*Barakat* (*Recorded January* 7).	*Wad Medani* (*from Record of Number of Holes Infected on September* 27).
1st (most infected)	Massey's Selected Domains	Massey's Selected Domains	Massey's Selected Domains.
2nd	Nahdah	Nahdah	Nahdah.
3rd	Sakel 186	Sakel 186	Sakel 186.
4th	Sakel Bolland 8	Sakel Bolland 8	Sakel Bolland 8.
5th	Main Crop (Gezira)	Sakel B/24	Main Crop.
6th (least infected)	Sakel B/24	Main Crop	Sakel B/24.

The agreement between these three determinations makes it tolerably certain that the order can be taken as the correct one for the season in question, and the results are particularly interesting in that the order of susceptibility varies considerably from that which was found to hold good for the same varieties grown at the same three stations last year.

Last year's order of susceptibility was:

1st (most)	Sakel B/24.
2nd	Massey's Selected Domains.
3rd	Sakel 186.
4th	Main Crop.
5th	Sakel Bolland 8.
6th (least)	Nahdah.

The improved behaviour of "Main Crop" in the present season may, perhaps, be attributed to the fact that the sample of seed

used for the variety plot this year had been obtained from Kassala instead of, as last year, from the Gezira tract itself. The increased susceptibility of Nahdah may also reasonably be attributed to the fact that this year's seed supply was obtained from last year's crop at Barakat, where it had had another year's chance to become impregnated with the disease.

The apparent decrease in susceptibility of Sakel B/24 is very difficult to account for, but it would seem that the only explanation of such decided differences from one year to another must rest in the degree of original infection of the seed used, as the order is affected in the same direction in all of the places where the seed was sown.

As regards boll-shedding, from the Shambat plot alone have we sufficiently full flower-count results to allow of deductions being made. Here the comparison between consecutive-day flower counts and their related yield data at three different periods of crop development suggests the following:

Worst shedder	Nahdah.
Bad	Massey's Selected Domains.
Not bad	Main-Crop Gezira.

The other three varieties appeared to occupy an intermediate position between Massey's Selected Domains and Main Crop Gezira.

At Barakat the crop lodged rather badly as a whole, and to a much less extent the same thing occurred at the other stations also. Nahdah invariably behaved badly in this respect, even under conditions, such as those at Shambat, which were not specially conducive to the exhibition of this failing. The next worst offender was Sakel B/24, while the most erect in all cases was Sakel Bolland No. 8. The behaviour of these three types was more or less in accordance with that noted last year, but the others gave very variable results.

The actual yields obtained in these trials are shown on p. 161, the varieties being arranged in order of yield. The standard error of mean difference has been computed and is shown in each case.

It will be seen that, judged on the basis of the standard error of mean difference, none of the varieties at Wad Medani can be said to differ significantly from each other in yield, and at Barakat it can only be said with confidence that Nahdah has done worse than the first three varieties. At Shambat the standard error was decidedly low, and here it can be stated that Nahdah has a significant lead over all other varieties, whilst Main Crop is below any of the first three varieties in order.

EGYPTIAN VARIETY TEST SERIES.

Shambat.		*Barakat.*		*Wad Medani.*	
Net Yield per feddan given by Control Variety, "Main Crop Gezira"=2·8 Large Kantars.		*Net Yield per feddan given by Control Variety, "Main Crop Gezira"=4·2 Large Kantars.*		*Net Yield per feddan given by Control Variety, "Main Crop Gezira"=3·7 Large Kantars.*	
Varieties.	*Mean Bed Yields in Rottles.*	*Varieties.*	*Mean Bed Yields in Rottles.*	*Varieties.*	*Mean Bed Yields in Rottles*
Nahdah ..	144·8	Sakel B/24 ..	175·4	Sakel 186 ..	154·8
Sakel Bolland 8	129·9	Sakel 186 ..	175·2	Massey's Selected Domains	152·3
Sakel B/24 ..	126·5	Massey's Selected Domains	169·0	Bolland 8 ..	150·4
Sakel 186 ..	121·6	Main Crop ..	166·4	Sakel B/24 ..	149·7
Massey's Selected Domains	119·5	Bolland 8 ..	155·6	Main Crop ..	147·2
Main Crop ..	113·1	Nahdah ..	138·6	Nahdah ..	140·3
Standard error of mean difference=5·3		Standard error of mean difference=10·8		Standard error of mean difference=8·2	

A consideration of the consecutive-bed yield graphs compiled from the data for these tests, together with information on the distribution of patches of high and low vigour, suggests that soil variations were sufficiently widely spread over contiguous plots to enable one to apply "corrections" to the above yields, with a fair presumption that the results will be rendered more accurate thereby.

These "corrected" yields are shown below, and it may be taken that the *direction*, at any rate, of the corrections—plus or minus—is likely to be reliable.

CORRECTED YIELDS.

(Varieties arranged in order of merit.)

Shambat.		*Barakat.*		*Wad Medani.*	
Varieties.	*Mean Bed Yields.*	*Varieties.*	*Mean Bed Yields.*	*Varieties.*	*Mean Bed Yields.*
Nahdah ..	143·8	Sakel B/24 ..	170·6	Selected Domains	155·8
Bolland 8 ..	127·2	Sakel 186 ..	166·6	Sakel 186 ..	154·4
Sakel B/24 ..	123·4	Selected Domains	166·6	Bolland 8 ..	150·6
Sakel 186 ..	122·6	Main Crop ..	165·6	Sakel B/24 ..	148·4
Selected Domains	119·0	Bolland 8 ..	161·4	Main Crop ..	146·2
Main Crop ..	115·6	Nahdah	141·6	Nahdah	136·0

It will be seen that only in one case is the order of yield actually changed, but that the differences between varieties are often considerably increased or reduced.

The reversal of position of the variety Nahdah in the two different districts, Shambat and the Gezira, is a repetition of what occurred last year, and points strongly to some condition at the former place which is specially favourable to this variety. Our data cannot as yet be made to throw light on the cause of this reversal.

A comparison of this year's results with those of last year is of interest as showing the points of resemblance. "Corrected" yields are taken as the criterion in the case of the current season's results, and the two plots in the Gezira (Wad Medani and Barakat) are taken together and averaged.

COMPARISON BETWEEN RELATIVE YIELDING POWER OF VARIETIES DURING THE LAST TWO SEASONS.

(Varieties arranged in order of yields obtained.)

Shambat Plot.		*Mean of Wad Medani and Barakat Plots.*	
This Year.	*Last Year.*	*This Year.*	*Last Year.*
Nahdah	Nahdah	Selected Domains	Sakel 186
Bolland 8	Bolland 8	Sakel 186	Selected Domains
Sakel B/24	Selected Domains	Sakel B/24	Sakel B/24
Sakel 186	Main Crop	Main Crop	Main Crop
Selected Domains	Sakel B 24	Bolland 8	Bolland 8
Main Crop	Sakel 186	Nahdah	Nahdah

The similarity between these two sets of results is striking and increases the probability of their correctness.

Detailed records made at Wad Medani on the plot there throw light on certain developmental differences between the varieties. These records were made on 18 plants per bed (*i.e.*, 90 plants per variety), and include observations on the following:

(*a*) Total number of nodes formed by plants up till September 27.
(*b*) Total number of nodes formed by plants up till October 24.
(*c*) Height of plants on both dates.
(*d*) Vigour of plants on both dates.
(*e*) Nodal position of lowest effective sympodium on October 24.
(*f*) Lowest remaining sympodia on January 6.

The accuracy of the information obtained was clearly shown by the fact that the two counts of total nodes per plant, made at a

month's interval, gave almost exactly the same relative results, bed by bed, within varieties.

On September 27 the varieties stood in the following order as regards rate of node production:

Main Crop.
Bolland 8.
{Massey's Selected Domains.
{Sakel B/24.
Sakel 186.
Nahdah.

The later count showed that Nahdah still continued to produce nodes at a slower rate than the rest and was, on the average, 1½ nodes behind the Main Crop Sakel by the end of October. By this time Sakel B/24 had just about caught up Main Crop in node rate, but Bolland 8 had fallen back to fourth place.

The total node curve for September 27 agrees so closely with the first picking curve that node rate must be considered to have been a major determining factor at that stage. This influence is not apparent in the yield curves of the second and third pickings, as compared with the node-production on October 24, and the inference is that other factors, probably Blackarm for one, have had a preponderating effect.

Node production, height and vigour are all connected, as shown by the resemblance between the curves which were plotted for those determinations, but vigour seems to be more closely associated with node rate than with height. Vigour presumably influences early yield through increased node-production rate.

Varieties were found to differ considerably in the nodal position of the lowest fruiting branch.

Data for the position of the lowest effective fruiting branch, compiled on October 24, give the following order for varieties:

Nahdah.
Sakel 186.
Sakel Bolland 8.
Sakel B/24.
Main Crop.
Selected Domains.

The varieties shown at the top of the list are those which produce fruiting branches lower down on the stem.

The order given above agrees in main features with that obtained last year, and is probably reliable. The curves constructed from these data, however, bear no resemblance, in this case, to the early

yield curves, and it is probable that the advantageous effect which might be expected from the habit of producing fruiting branches low down on the stem is offset by other factors, such as Blackarm.

Figures for ginning out-turn are available only in the case of the Shambat plot, where the varieties gave the following results:

	Per Cent.
Nahdah	33·5
Main Crop	32·1
Sakel 186	31·8
Bolland Sakel 8	31·5
Selected Domains Sakel	31·1
Sakel B 24	30·7

B. (1.) American Varieties (Standard Series). Irrigated Plots.

(i.) Shendi (Sown July 6).
(ii.) Moeis (Sown July 4).
(iii.) Kober (Sown July 19).

These three plots showed less similarity in their results than was the case in the previous season. If, however, the case of Delta Webber be omitted, a very fair resemblance is apparent, especially between the Kober and Shendi plots which are situated on similar soils. The general order of yield of the five varieties, allowing for the probably abnormal Shendi result, referred to below, would appear to be:

Pump Scheme Strain.
Pedigree Dixie.
Columbia 40.
Webber 38.
Delta Webber.

This agrees with last year's conclusions as regards all except Columbia 40, which was not included in the series last year.

At Shendi, Delta Webber gave a much higher proportionate yield this year than at the other localities. An examination of the separate yields from successive pickings from this plot, as compared with the other "identical" plots, suggests that Delta Webber has, in this case, scored chiefly through the relatively poor performance of the other varieties at the latter end of the picking season.

A flower count taken at the end of October showed that the four other varieties should have been well ahead of Delta Webber in crop production during January, and this would, doubtless, have been the case if it had not been for an exceptionally severe attack of Flea-Beetle which developed during the first two weeks in November and practically destroyed the green tops of the bushes. At the time

of this attack the crop of bolls which was already maturing for picking in mid-December was sufficiently advanced to be unaffected, but the flowers just opening or about to open, being still in the susceptible stage, must have shed very heavily.

A detailed estimate of the severity of the Flea-Beetle attack was made on October 29, and it is interesting to find an indication that Delta Webber was relatively less severely attacked than all other varieties except Columbia, which last also did *relatively* well in the January-February pickings.

This case provides an interesting example of the value of detailed records, made during the course of development, in explaining anomalous results from variety or other field tests with cotton, and numerical data obtained are summarized below in words to illustrate this point:

(1) *Variety.*	(2) *Potential crop in Jan.-Feb. as indicated by Flowering Rate at end of Oct.*	(3) *Severity of Flea-Beetle attack in Nov.*	(4) *Relative Yield in Jan.-Feb. (can be interpreted as a balance between 2 and 3).*	(5) *Relative Total Yields for season, with suggested reasons for relative position of varieties.*
Webber 38 ..	Medium.	Most severe.	Lowest.	Lowest.
Pump Scheme Strain ..	High.	Severe.	Good medium (about same as for Delta Webber).	Highest (due to excellent mid-early yield characteristic of this type in all plots, and to good late recovery after attack).
Delta Webber	Low.	Medium only.	Good medium.	Second highest (due to characteristic good early performance and to relatively less heavy damage from flea-beetle).
Pedigree Dixie	Rather low.	Severe.	Medium.	Medium.
Columbia 40..	Highest.	Least severe.	Highest.	Second lowest (due to characteristically low yields given in early pickings).

The following Table summarizes the total yield results obtained from these three plots. Apart from the abnormal yields at Shendi indicated above, the figures may be taken as being fairly reliable, as

the stand of plants was for the most part satisfactory, and was never sufficiently irregular to produce any obvious effect on the early yields.

AMERICAN VARIETY TEST: IRRIGATION CONDITIONS.

SHENDI.		MOEIS.		KOBER.	
Net Yield per feddan given by Control Variety (Pump Scheme Strain)= 3·7 Large Kantars.		*Net Yield per feddan given by Control Variety (Pump Scheme Strain)= 6·9 Large Kantars.*		*Net Yield per feddan given by Control Variety (Pump Scheme Strain)= 4·0 Large Kantars.*	
Varieties.	*Mean Bed Yields in Rottles.*	*Varieties.*	*Mean Bed Yields in Rottles.*	*Varieties.*	*Mean Bed Yields in Rottles.*
Pump Scheme Strain	147·7	Pump Scheme Strain	271·1	Pump Scheme Strain	159·3
Delta Webber ..	132·6	Pedigree Dixie ..	266·5	Columbia 40 ..	140·9
Pedigree Dixie ..	114·8	Webber 38 ..	245·3	Pedigree Dixie ..	131·8
Webber 38 ..	107·1	Columbia 40 ..	228·1	Delta Webber ..	124·7
Columbia 40 ..	106·3	Delta Webber ..	218·8	Webber 38 ..	124·1
Standard error of mean difference=6·7		Standard error of mean difference=10·9		Standard error of mean difference=9·1	

The yields shown above represent the relative behaviour of the varieties as grown on the particular plots where they were sown. Differences between mean bed yields of over three times the standard error may be considered to be significant.

Our results enable us to make some allowances for local soil variations which occurred within the plots, and the figures thus obtained should be of more general application.

The results thus " corrected " stand as follows

CORRECTED YIELDS.

(Varieties arranged in order of merit.)

Shendi.		*Moeis.*		*Kober.*	
Varieties.	*Mean Bed Yields.*	*Varieties.*	*Mean Bed Yields.*	*Varieties.*	*Mean Bed Yields.*
Pump Scheme ..	144·8	Pump Scheme ..	268·2	Pump Scheme ..	144·8
Delta Webber ..	128·4	Pedigree Dixie	265·0	Columbia 40 ..	134·6
Pedigree Dixie	116·4	Webber 38 ..	238·8	Pedigree Dixie	131·0
Columbia 40 ..	107·8	Columbia 40 ..	234·2	Webber 38 ..	131·0
Webber 38 ..	104·6	Delta Webber ..	221·4	Delta Webber ..	124·0

The above corrections will be found to have resulted in varieties changing places in two cases.

If, in view of the abnormal conditions which occurred at Shendi, we take the mean values for the two plots Kober and Moeis only, we get the order of yield shown below which agrees with last year's determination:

Means of Kober and Moeis only, 1927–28.		Means of Kober, Moeis and Shendi, 1926–27.	
Varieties.	*Corrected Mean Bed Yields.*	*Varieties.*	*Mean Bed Yields.*
Pump Scheme	206·4	Pump Scheme	201·0
Pedigree Dixie	198·0	Pedigree Dixie	182·0
Webber 38	184·6	"Gendettu"*	178·0
Columbia 40	184·4	Webber 38	174·0
Delta Webber	171·6	Delta Webber	156·0

Apart from the yield figures, the following deductions, based on serial observations made during the growth and harvesting of the crop at all three places, are also of value in deciding the relative usefulness of the types tried, under conditions of irrigation.

Pump Scheme Strain.—A rather tall slender type, usually rather vigorous in growth. Medium late starter as regards crop production, but gives a good mid-early crop and a particularly good late crop. Boll-shedding, judged on relation between flowering and subsequent yield, is "normal." Growth tends to continue well on to the end of the season. Nodal position of lowest fruiting branches is variable. Rather badly attacked by Flea-Beetle.

Pedigree Dixie.—A stout stemmed type, with a very marked tendency to lodge badly. Rather a late starter, but later pickings are a good average or rather above. Boll-shedding (reference flower curves) is "normal." Shows medium rapid rate of node-development and fruiting branches are borne medium low. Badly attacked by Flea-Beetle.

Columbia 40.—Tall and decidedly vigorous in growth. Does not lodge badly. Definitely slow in rate of early node-formation. Fruiting branches borne rather high on stem. Later in starting to crop than any of others, and only does well in the mid-late and late pickings. Shedding is variable.

* Columbia 40 was substituted this year in place of Gendettu.

Webber 38.—Erect and stout in habit, but not vigorous in growth. Early node-production rate is average. Fruiting branches not produced low down. Appears to be decidedly liable to boll-shedding, and was much attacked by Flea-Beetle. Not an early starter; fairly good mid-season cropper, but tails off in later pickings.

Delta Webber.—Decidedly earlier in starting to open its bolls than the other varieties, but, after producing a satisfactory early crop, it tails off in later pickings. Less vigorous in growth than others. Early node-production rate is medium to rather slow, but fruiting branches are borne lower down on the stems than in others. The stems are stout and rather inclined to lodge if the plants are growing strongly. It was not much attacked by Flea-Beetle and appeared to shed less than any of the other types in the series.

As regards ginning out-turn, the figures obtained for the different varieties were as follows:

Ginning Out-Turn (Percentages).

Kober (*First Five Pickings*).		*Shendi* (*Fourth Picking*).	
Pedigree Dixie	33·7	Pedigree Dixie	32·7
Delta Webber	30·6	Columbia 40	31·1
Pump Scheme	29·4	Delta Webber	29·6
Columbia 40	29·3	Pump Scheme	28·7
Webber 38	28·2	Webber 38	28·5

The order at the two places agrees well except in the case of Columbia 40. At Moeis, figures are available for the fifth picking only, but these run in the same order as at Kober, except in the case of Pedigree Dixie, where the figure actually obtained was so low as to suggest accidental circumstances.

B. (2.) American Varieties (Standard Series). Rain-Grown.

(i.) Talodi (Sown June 26-29).
(ii.) Kadugli.
(iii.) Sabonabi es Sherig (Sown July 28).
(iv.) Ghati (Sown July 25).

Out of the four plots which were laid down, two in Fung Province (Sabonabi and Ghati), and two in the Nuba Mountains (Talodi and Kadugli), satisfactory results have been obtained in three cases. At Kadugli the occurrence of serious differences between the picking weights and check weights made it necessary to cancel the results.

The Sabonabi and Ghati plots were situated on heavy black cotton soil, within three miles of each other, in Fung Province. It

is interesting to compare the low yields obtained from these plots with the relatively high yields (over 900 lbs. per acre) at Talodi, under practically the same rainfall. The difference is partly due to the more even distribution of rainfall at the latter place, but it is probable that the nature of the soil and subsoil had rather more to do with it. At Talodi the surface soil is a rather dark-coloured, heavyish loam, overlying a subsoil of decomposed granite. It is more than probable that a certain amount of lateral flow of water takes place through the subsoil from the mountain sides.

The following Table gives the actual results obtained from these three plots:

American Variety Test Series: Rain-Grown Conditions.

Talodi.		Sabonabi.		Ghati.	
Net Yield per feddan given by Control Variety (Pump Scheme Strain) = 2·9 Large Kantars.		*Net Yield per feddan for Pump Scheme Strain= 0·9 Large Kantars.*		*Net Yield per feddan for Pump Scheme Strain= 0·9 Large Kantars.*	
Varieties.	*Mean Bed Yields in Rottles.*	*Varieties.*	*Mean Bed Yields in Rottles.*	*Varieties.*	*Mean Bed Yields in Rottles.*
Pedigree Dixie ..	106·0	Webber 38 ..	29·8	Delta Webber ..	32·6
Delta Webber	104·2	Delta Webber ..	28·9	Webber 38 ..	29·6
Columbia 40 ..	94·8	Pump Scheme ..	28·2	Pump Scheme ..	29·1
Pump Scheme Strain	90·4	Pedigree Dixie ..	25·0	Pedigree Dixie ..	28·8
Webber 38 ..	87·4	Columbia 40 ..	24·1	Columbia 40 ..	26·9
Standard error of mean difference=6·6		Standard error of mean difference=2·5		Standard error of mean difference=2·0	

Except for Columbia 40, which was on trial for the first time this year in these plots, the order of yield of the varieties at Talodi is the same as in the previous year's plot.

If the figures given above are considered only in relation to their appropriate standard errors of mean difference, it will be found that the most that can be said, in the case of each plot, is that the two varieties at the top of each list are probably significantly higher than the lowest one in the same plot. The close agreement, however, between the results of the two plots in Fung Province and between those from this year's and last year's plot at Talodi suggests that more

confidence can be placed in the results than is indicated by the above method of comparison. Further, in view of the extremely regular stand of plants obtained at all the plots, the serial yield records available enable one to make certain corrections for soil irregularities.

The " corrected " yields come out as follows:

Corrected Yields (Varieties arranged in Order of Merit).

Talodi.		Sabonabi.		Ghati.	
Varieties.	*Mean Bed Yields.*	*Varieties.*	*Mean Bed Yields.*	*Varieties.*	*Mean Bed Yields.*
Delta Webber ..	104·4	Webber 38 ..	29·6	Delta Webber..	32·2
Pedigree Dixie	101·6	Delta Webber ..	29·5	Pump Scheme	29·3
Columbia 40 ..	93·8	Pump Scheme..	28·2	Pedigree Dixie	28·6
Pump Scheme ..	93·1	Pedigree Dixie	25·2	Webber 38 ..	28·4
Webber 38 ..	89·9	Columbia 40 ..	23·9	Columbia 40 ..	26·0

The result of these corrections is to make the order of yield from the Fung plots come more into line with those from the Talodi plot, but it is still apparent that Columbia 40 and Pedigree Dixie are the first to suffer under the more stringent conditions of water-supply in the Fung Province.

Taking all these three plots together, the mean values for varieties come out as follows:

	Uncorrected.	*Corrected.*
Delta Webber	55·2	55·4
Pedigree Dixie	53·2	51·8
Pump Scheme	49·2	50·2
Webber 38	48·8	49·2
Columbia 40	48·6	47·2

It will be seen that the order of yield is, in this case, unchanged by the corrections applied, but that Pedigree Dixie and Columbia 40 are proportionately reduced in yield.

The order of merit thus obtained is probably a very close approximation to the true one for areas of light or medium-light rainfall, and bears out the conclusions which were tentatively reached last year.

As pointed out in last year's report, Delta Webber is a much superior class of cotton to Pedigree Dixie, which is its nearest rival in yield, and usually runs at about $\frac{1}{8}$ inch longer in staple. This

naturally enhances the actual value of the former on a basis of yield multiplied by price.

It may safely be said that the indications are rather strongly in favour of introducing Delta Webber to replace the present Pump Scheme variety in this particular zone of climatic conditions.

Graders' reports on this variety have been satisfactory, but it is necessary to observe caution at this stage in view of conflicting results given by samples from the previous year's crop when put through the full spinning test.

Meanwhile, as noted elsewhere in this report, certain single-plant selections, made from this variety at Shambat, which are known to be an improvement on the original type in vegetative character, and probably so in quality, are being multiplied up as rapidly as possible, in order to provide a supply of pure " improved " seed.

Separate ginning outturn figures for the varieties are available for the Sabonabi plot only, and give the following order for the varieties:

	Per Cent.
Pedigree Dixie	25·7
Pump Scheme	24·3
Delta Webber	24·1
Webber 38	22·5
Columbia 40	21·2

It will be noted that the figures are all very low, reflecting the decidedly droughty conditions at Sabonabi. The varieties run in approximately the same order as for the irrigated plot at Kober.

In general, these three rain-grown plots have proved very satisfactory from the experimental point of view, and show clearly that useful and reliable results can be obtained from such situations.

Special new methods were employed for obtaining regular spacing between the plants and more than repaid the extra trouble involved in carrying out the work. In no case were there any grounds for considering that the final yield was appreciably affected by irregularities in stand.

At Sabonabi and Ghati, owing to the impossibility of providing adequate supervision, the bunches of seedlings were thinned down to 3 instead of to 2 plants per hole, and this extra crowding doubtless also had an important effect in reducing the yield from these two plots, but as the work was done regularly, it probably had little influence on the relative performance of the varieties.

In all cases it was found to be possible to keep the weeds in check very effectually.

The following more detailed observations on the behaviour of

individual varieties, when grown under these conditions, are based on notes made during the progress of the growing crop:

Delta Webber.—Definitely early, more especially under Talodi conditions. It appears not to be prone to shedding, and it is probably due to this and to its earliness that it is, on the whole, the most satisfactory variety in these trials. The yield falls off in later pickings, but the curtailment of the picking season by drought in these parts causes this lack of staying-power to be a matter of minor importance only. It is a low-growing type, with rather too much tendency to lodge, but the indications are that this fault can readily be corrected by selection.

Pedigree Dixie.—Rather a late starter. Under the less droughty conditions at Talodi it soon caught up and surpassed other varieties, but in Fung Province it never really got going. Boll-shedding is variable, being apparently heavy under conditions of abundant moisture and rather light under drier conditions. It is a short growing type, much inclined to lodge. At Talodi it appeared to be rather less susceptible to Blackarm than most.

Pump Scheme.—Of average earliness: sometimes a trifle slow in making a start. It gave a good average performance in the mid-early pickings, but never got a chance in any of these plots to produce the heavy late crop characteristic of this type. It is tall-growing, and is very variable in the matter of production of vegetative branches. It appears to shed badly under dry conditions, but relatively slightly when moisture is abundant.

Webber 38 proved to be decidedly variable with locality in the matter of earliness. In the Fung plots it made rather an early start, and gave a satisfactory plant of medium height. At Talodi it was late in starting to flower, and this fact appears to account for its low position there in the scale of yield. It appears to be relatively good in the matter of boll-shedding.

Columbia 40.—This is the latest starter of all varieties tried. It usually improved its position later, but never soon enough to make up the early deficiency. It is medium in height and tends to produce rather a lot of monopodial branches. It appears to be more susceptible to shedding under both wet and dry conditions than the other types tried.

5. Graders' and Spinning Tests.

These tests necessarily take some time to carry out; in order, therefore, that the publication of the remainder of the Report may not be delayed, the results of the tests must be incorporated with

the Report for the following season. Reference must accordingly be made to last year's Report for details of the field trials of the cottons to which the following results relate. Similarly, it is unfortunately not possible to include here any reports on the behaviour of the cottons grown in the present season, 1927-28, as these are not yet available.

The following notes summarize the information which has been received up to date on the samples submitted from the previous year's crop (1926-27).

In a large number of cases the same varieties have been grown again in the present year, so that, to a great extent, the results may be applied to the material described in Sections 3 and 4 above.

Certain of the results are very difficult to explain at the present stage. It is hoped that it may be possible to clear up some of these cases when the laboratory work on the measurable characters of these cottons, which is being carried out at the Shirley Institute, Didsbury, has been brought to a conclusion.

We are very much indebted to the Director and staff of the Shirley Institute, who have kindly made the arrangements for spinning tests and laboratory work, to Messrs. Wolstenholme and Holland, who have furnished us with the graders' reports, and to those firms who have very generously carried out the actual spinning, at the cost of considerable dislocation of ordinary work.

From the grower's point of view the principal object of these tests is to ascertain the true market value of the cotton which he is producing. When varieties are being tested against one another with a view to deciding which should be grown, it is clear that the choice will normally fall on the type which gives the highest value for the product "Yield × Price." It is, however, by no means a simple matter to apply this test.

In the first place, the yield of lint from seed cotton varies not only from one variety to another, but from place to place and from one picking to another, and also from one season to another with the same variety. It is really necessary to determine the ginning out-turn for every picking of every bed of each variety, but the time and labour involved in this are almost prohibitive, and the frequent stoppages of the gin would cause the product to be irregular.

In the next place, it is impossible to obtain a valuation of lint samples which does not include *extrinsic* factors such as the quantity of dust or broken leaf which is present, or the occurrence of streaks of stained cotton.

Manifestly the only "price" which is of any use for our purposes

is one which is based solely on length, strength, fineness, and general "spinnability" of the cotton.

It may be said that the final test is really the spinning test itself, but here again many difficulties arise. Cottons spun to different counts cannot safely be compared, and, with the present arrangement of machinery in mills, it is found necessary at times not only to spin different cottons to different counts, but to spin separate pickings of the same cotton differently.

Further, the value of a cotton for spinning purposes depends not on one but on several factors, of which strength, waste, levelness, lustre, and general adaptability to mercerization processes may be mentioned. No single figure can be used to express the sum of all these factors, and the spinner himself depends on the grader to obtain for him the cotton which will best suit his purposes. We are thus thrown back on to graders' valuations once more, with their inherent difficulties in the matter of interpretation, and with the knowledge that not infrequently graders' opinions are not confirmed by the results obtained in spinning.

In working through the present set of data all these points have been borne in mind, and as far as possible the difficulties have been allowed for. All "graders' prices" have been "corrected" on the basis of prices current at the time of valuation, so as to bring all the cottons on to the same theoretical "grade"—the nearest to the "average" grade of the whole lot. It is considered that the application of this "correction" is permissible where the range of actual grades shown by the samples is small.

Only a very bare summary of the results is given here, and in order to make the figures more easily comparable, the data obtained for the important factor of yarn-strength are shown in graphical form.

All the yarns were tested in two ways for strength—"lea test" and "ballistic test." In general the results of these two methods run more or less parallel, but important cases of divergence will be noticed, especially in the case of American varieties at Shendi (Fig. 4). Of the two, the ballistic method probably gives the more reliable results.

The figure shown for "strength" is in all cases the *product* of strength by count, this being given in preference to the bare figure for strength, as it tends to eliminate small differences in count between successive samples.

The data are arranged here in groups according to the particular experiments or tests to which they refer.

(*a*) *Small Propagation Plots* (*Shambat*, 1926-27).

Varieties tested:

Bolland Sakel 19.3.
Bolland Sakel 8.
Sakel 186/24.

Data are shown graphically in Fig. 1.

None of these were priced above commercial Sakel of the same grade. Bolland Sakel 8 was certainly lower.

Waste from these cottons was satisfactorily low. Sakel 186/24 gave easily the best results, both in grading and spinning, and was notable as being described as of good colour—an unusual feature in Sakels from this district.

None gave yarns as strong as the control, but all were strong, Sakel 186/24 being the best. Sakel 186/24 and Bolland 19.3 both gave a very nice even sample of yarn.

(*b*) *Preliminary Variety Test* (*Shambat* 1926-27).

Varieties tested:

N.T. 25/24 (a selection from Uppers).
Massey's Selected Domains Sakel.
Garofallou.
S.I.D. 3.2.
S.I.A. 2.7.
S.I.D. 14.1.
S.I.D. 1.8.

The data are shown graphically in Fig. 2. It will be noted that two different counts were employed in spinning, a " control," made up at the mill, being used with each lot. The two different lots are not comparable *inter se*.

The general conclusions are as follows:

N.T. 25/24 was valued at about 25 points on Uppers *of same grade*, but gave disappointingly low results when spun.

Massey's Selected Domains Sakel was deceptively poor and brown in appearance, and was classified as Pelion at $1\frac{1}{4}$ to $1\frac{5}{16}$ inch staple, but at less than Pelion price. It was spun at Pelion counts, but the results show that it had been underestimated, the resulting yarn being much stronger than the control and notably good in appearance. It also gave a decidedly low comber waste, which may be taken as a further indication that it had been wrongly placed. This same variety was also included in the " Egyptian Variety Test " at Wad Medani (see below) when the results all through were extremely satisfactory.

Garofallou.—This was also classed as a Pelion at $1\frac{5}{16}$ inch staple, but priced at more than 100 points on on the same grade. It was

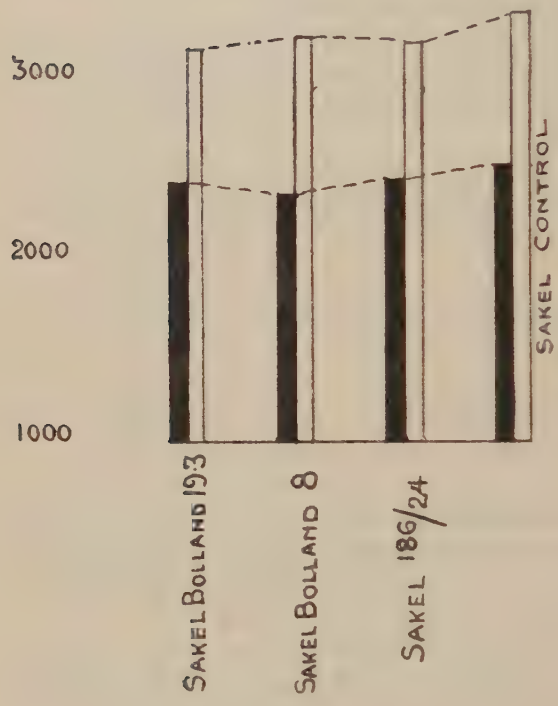
FIG 1 SHAMBAT EXPERIMENTAL FARM 1926-27

SMALL PROPAGATION PLOTS

(SAMPLES DRAWN FROM ALL PICKINGS MIXED TOGETHE

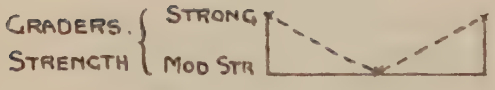
YARN STRENGTH (STRENGTH x COUNT PRODUCT)

← 90's TWIST (COMBED) →



RESULTS OF LEA TESTS INDICATED BY BLACK COLUMNS.

RESULTS OF BALLISTIC TESTS INDICATED BY WHITE COLUMNS



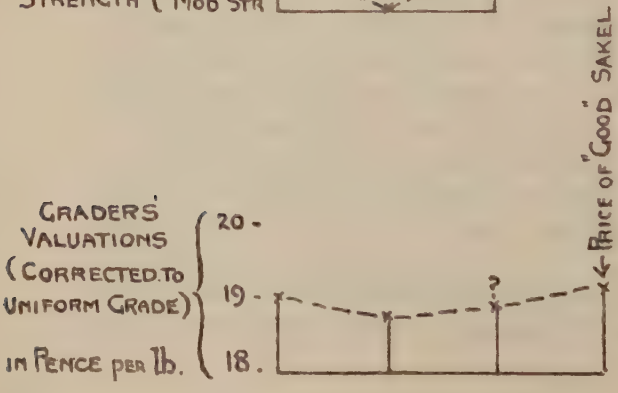
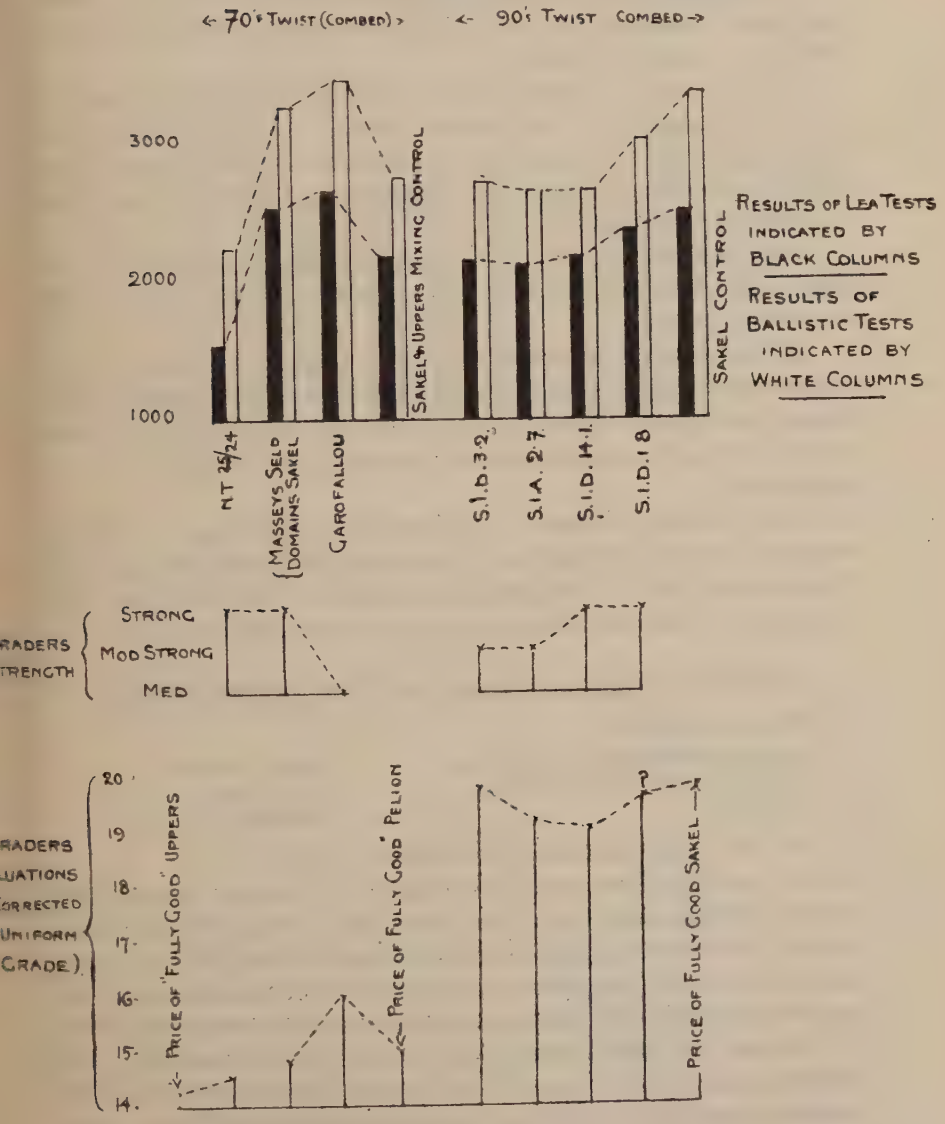


FIG 2 SHAMBAT EXPERIMENTAL FARM 1926-27.

PRELIMINARY VARIETY TEST.

(SAMPLES DRAWN FROM 4TH PICKINGS ONLY)

YARN STRENGTH (STRENGTH × COUNT PRODUCT)



underspun and gave an exceptionally strong yarn, but was rather irregular.

Comber waste, as in the last case, was very low indeed. This variety may be said to have put up a particularly good performance in the spinning tests, and, though not a Sakel in appearance, could doubtless be spun to Sakel counts.

It gave a comparatively poor yield in 1926-27, but in the season just past it headed the list in this preliminary yield-trial. It is clearly worth further trial.

"*S.I.*" *Types.*—These were all classed by the graders as "Sakels," "cream" in colour or even "rather brown." S.I.D. 1.8 and S.I.D. 3.2 were judged to be about 1½ inch staple, and priced at about Sakel price for the same grade. The others were "shorter," and were priced below standard.

Card waste was in all cases slightly below standard, but the more important comber waste was slightly above, except in the case of S.I.D. 1.8.

The yarns in all cases were lacking in strength, except S.I.D. 1.8, which gave quite a strong yarn, but not up to the control. This variety was specially noted as giving a "very good-looking" yarn. S.I.D. 3.2 was the next best in appearance, both being better than the control.

In view of the satisfactory yields given by these types in 1926-27, they will be given further trial, despite the fact that they have not behaved very well in the grading and spinning tests, and that they have failed in the season just past to equal the control in yield.

(*c*) *Standard Egyptian Variety Test* (*Wad Medani*, 1926-27).

Varieties tested:

Sakel Gezira Main Crop (Sulfab seed).	Sakel Bolland 8.
Massey's Selected Domains Sakel.	Sakel 186.
Sakel B/24.	Nahdah.

(See Fig. 3 for graphical presentation of data.)

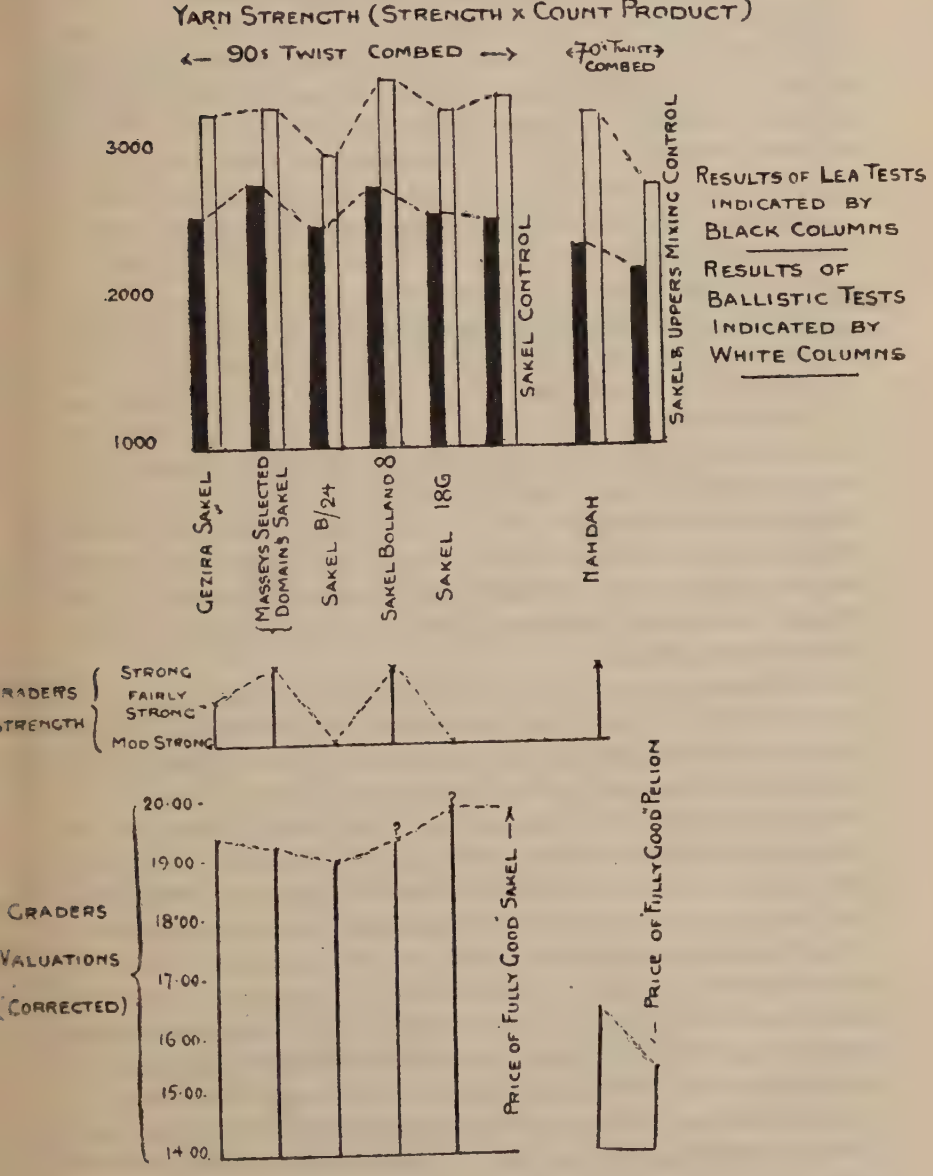
The varieties here are all represented by samples drawn from second pickings only, and it is important to remember that their relative performance might have varied considerably had other pickings been studied (see general notes above, and compare also the behaviour of American varieties in successive pickings described below).

All the five Sakels were spun to 90's Twist (combed). The Nahdah, which is an improved Assili-type, was spun to 70's Twist (combed), against a separate control mixing made up of 50 per cent. Sakel and 50 per cent. Uppers.

FIG 3. WAD MEDANI 1926-27.

EGYPTIAN VARIETY TEST

(SAMPLES DRAWN FROM 2ND PICKINGS ONLY)



This last type was classed by the graders as " Assili " of $1\frac{1}{4}$ to $1\frac{5}{16}$ inch staple at a price of about 100 points on Pelion of the same grade (" Fully good "). It spun better than its control, but was not specially good at 70's.

The Sakels were all graded at staple lengths between $1\frac{5}{16}$ to $1\frac{1}{2}$ inches. It is interesting to find that Massey's Selected Domains, which, when grown in the Preliminary Variety Test (see above), was classed as a Pelion and priced at 14·75 pence, was here classed as a Sakel at a price 450 points higher (same grade), and is described as being " strong and of good colour; lustrous and silky." It was spun with the other Sakels in this case, and gave the best results of all on the lea test, though only fourth best by the ballistic method.

The two types Sakel Bolland 8 and Sakel 186 are the same as were included in the tests from the Small Propagation Plots (see above), but here their position is reversed.

Sakel Bolland 8 graded surprisingly well in the present case, and gave a nice even yarn which proved to be the strongest of the lot according to the ballistic test. It was classed as $1\frac{1}{2}$ inch staple.

On the whole, all these Sakels gave satisfactory results except, perhaps, Sakel B/24, which graded poorly and was distinctly down on the others in yarn-strength, though the finished yarn was placed highest in order of appearance. In the opinion of the spinners, the majority of these cottons would spin up to 120's weft easily. In the lea tests all gave higher results than the control, except B/24, but when the ballistic method was employed, the control came out second only to Sakel Bolland 8.

As explained in the beginning of this note, the tests summarized above were carried out on samples from the 1926-27 crop. Exactly the same series of varieties were grown again in the following year (1927-28), in three separate and similar plots. The field results from these latter plots are described on pp. 22-29 of the present Report (Egyptian Standard Variety Test Series). The figures for ginning percentage are only available for the Shambat plot, and if we assume that these are sufficiently nearly correct for the other plots, we can obtain figures representing the yield of lint for these varieties. If we further assume that we are justified in applying the graders' valuations of the samples from the 1926-27 crop to the corresponding cottons from the 1927-28 crop, we can obtain a provisional order of merit for the 1927-28 plots, based on cash-return per unit area.

The figures are as follows, but must be accepted with the greatest reserve, recognizing that they involve the two assumptions mentioned above:

Variety.	*Wad Medani.*		*Barakat.*		*Shambat.*	
	Lint-Yield × Price.	*Order of Merit.*	*Lint-Yield × Price.*	*Order of Merit.*	*Lint-Yield × Price.*	*Order of Merit.*
Sakel 186	976	1.	1,052	1.	775	1.
Massey's Selected Domains	931	2.	996	3.	711	6.
Sakel Bolland 8	916	3.	983	5.	774	1.
Gezira Main Crop	907	4.	1,029	2.	718	4.
Sakel B/24	865	5.	994	3.	719	4.
Nadhah	752	6.	758	6.	771	3.

N.B.—The table is based on "corrected" field yields and "corrected" graders' valuations.

The consistently high position shown by Sakel 186 in the above table makes this variety worthy of considerable attention, especially as it headed the list of yields at both Barakat and Wad Medani in the previous year's trials.

(*d*) *Standard American Variety Tests* (1926-27).

As explained earlier in this Report, this series of tests covers a range of soils and climates, the same varieties being used in each case. The results of the graders' reports and of the spinning tests are, therefore, of particular interest.

As it was impossible to arrange for tests to be carried out in every case, two localities were selected from which to send samples. The two places fixed on were Shendi, in the Northern Sudan, where rainfall is practically nil and the crop is grown almost entirely by irrigation, and Talodi (Nuba Mountains Province), where a rainfall of about 30 inches is the sole source of water-supply.

In each case samples were taken to represent the beginning, the middle, and the end of the picking season.

The actual samples sent for testing were:

		Varieties.
Shendi	First picking Fourth picking Eighth picking	Gendettu. Delta Webber. Webber 38. Pump Scheme Strain. Pedigree Dixie.
Talodi	First picking Third picking Fourth and fifth pickings	Gendettu. Delta Webber. Webber 38. Pump Scheme Strain. Pedigree Dixie.

It should be noted that owing to the shortness of the rainy season, the fifth picking at Talodi usually represents the finish of the crop in that district.

As regards graders' tests, it is of interest to note that in both localities all the varieties except Pedigree Dixie obtained a higher *average* valuation than the Pump Scheme strain, the average premium varying from 2 to 69 points on. Further, the samples from Shendi, taken all together, gave an average premium of 100 points over the similar series of samples from the rain-grown plot at Talodi.

All the varieties were regarded as being of high quality, and were priced at from 197 to 359 points on standard American cotton *of the same grade*, equivalent to a difference of 225 to 387 points on basis American Middling of the same date.

Grade at Talodi varied only within the limits of Good Middling to Strict Good Middling, the last pickings being, on the average, as high in grade as the first.

At Shendi the grades for the first and fourth pickings showed the same range as at Talodi, but the average was slightly higher. In the eighth picking two of the varieties dropped to Strict Middling, but the others maintained the same level as in previous pickings.

The first and fourth pickings at Shendi averaged about one-sixteenth of an inch longer than the corresponding pickings at Talodi, the difference between the early and mid-season pickings being very little. The final pickings at the two places gave almost identical results as regards staple length, the drop as compared with early pickings being greater at Shendi than at Talodi. The difference between the first and last pickings at Shendi was rather over one-sixteenth of an inch.

The grader's estimations of strength are summarized below:

Variety.	*Shendi.*		
	First Picking.	*Fourth Picking.*	*Eighth Picking.*
Gendettu	Medium	Strong	Moderately weak.
Delta Webber ..	Moderately strong	Moderately strong	Medium.
Webber 38 ..	Strong	Medium	Medium.
Pump Scheme ..	Strong	Strong	Weak.
Pedigree Dixie ..	Fair	Moderately strong	Very weak.

Variety.	*Talodi.*		
	First Picking.	*Third Picking.*	*Fourth and Fifth Pickings.*
Gendettu	Moderately strong	Medium	Moderately strong.
Delta Webber ..	Strong	Moderately strong	Moderately strong.
Webber 38 ..	Rather weak	Rather weak	Medium.
Pump Scheme ..	Medium	Moderately strong	Medium.
Pedigree Dixie ..	Medium	Medium	Medium.

It will be seen that the Shendi samples gave the better impression, with the exception of the eighth picking at that place, which was decidedly poorer than the rest. This is doubtless connected with the condition of senescence which the plants had fully reached by that time.

In both localities Pump Scheme cotton showed a very rapid falling-off in quality after the first picking. This was reflected in the valuations of this variety, which were near the top of the list for the first pickings, but either lowest or lowest but one for the middle and final pickings. This behaviour is almost certainly due to the mixed nature of this particular strain. Hybrid plants are in general both early and vigorous, and this hybrid vigour doubtless affects also the length and quality of the lint. The first picking in such cases might be expected to be of specially good quality, but the subsequent pickings would contain cotton from the numerous short-linted later plants and would, in consequence, be below the general level of quality.

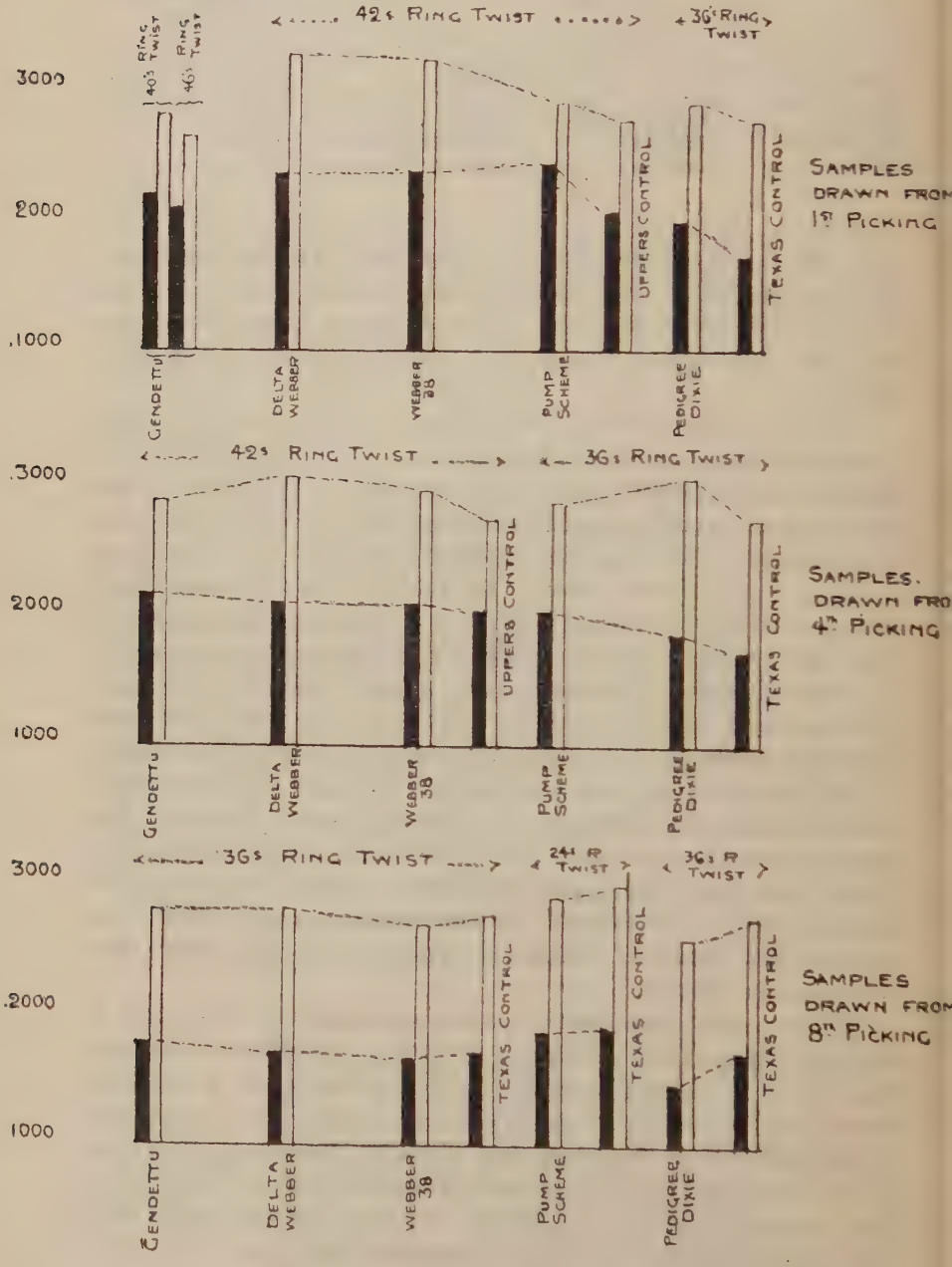
The spinning tests from these samples have also given interesting results. Waste losses were usually distinctly on the low side. The samples from the rain-grown plot (Talodi) gave lower losses on the whole than those from the irrigated plot. Only in the case of the final pickings from Shendi did the waste losses normally exceed those given by the " control " samples of Texas cotton against which they were spun in the mills.

The yarn-strength results are shown graphically in Figs. 4 and 5. It will be noted that the same variety has, on different occasions, been spun to varying counts. Only varieties spun to identical counts can properly be compared. In every case except one (" Gendettu " in the first picking at Shendi) a control type was spun at the same count for comparative purposes. Texas cottons were used as controls for the lower counts, but where a count of 42's Ring Twist was employed a sample of Egyptian Uppers was used. The

FIG. 4 SHENDI. 1926-27

AMERICAN VARIETY TEST (IRRIGATED CONDITIONS.)

YARN STRENGTHS AS MEASURED BY STRENGTH x COUNT PRODUCTS

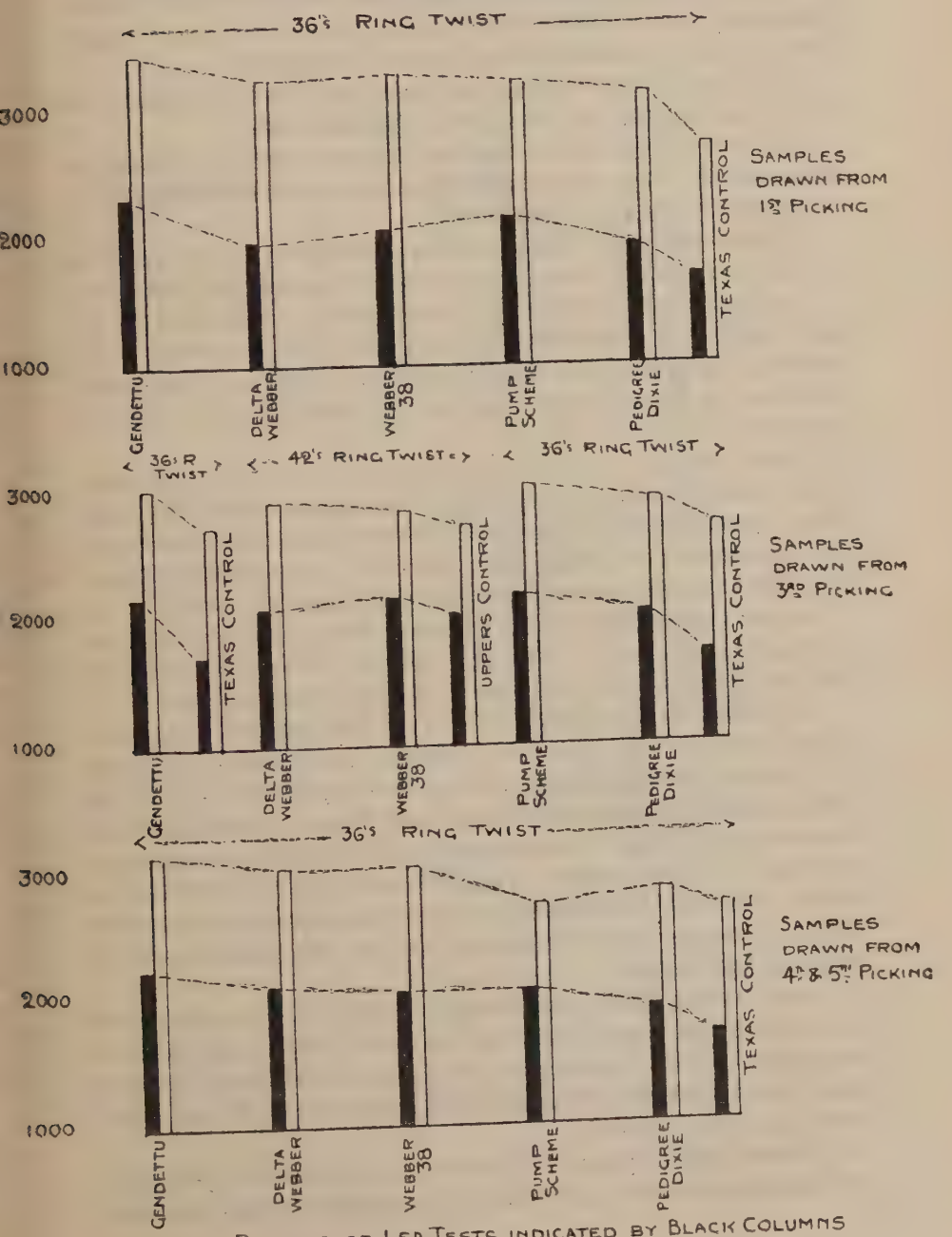


NOTE { RESULTS OF LEA TESTS INDICATED BY BLACK COLUMNS
DO BALLISTIC TESTS DO WHITE COLUMNS

FIG. 5. TALODI 1926-27

AMERICAN VARIETY TEST (RAIN-GROWN CONDITIONS).

YARN STRENGTHS AS MEASURED BY STRENGTH × COUNT PRODUCTS.



NOTE { RESULTS OF LEA TESTS INDICATED BY BLACK COLUMNS
DO BALLISTIC TESTS DO WHITE COLUMNS

selection of this latter type as a control is an indication of the high quality of the cottons which were spun to this count.

Practically all the samples sent in gave higher yarn-strengths than their controls, the only exceptions being from the eighth picking at Shendi, where Pump Scheme, Webber 38, and Pedigree Dixie all failed to reach the standard of the control.

The results must be considered very satisfactory, especially in those cases in which 42's Ring Twist was employed.

The results from these tests are, however, rather confusing in some respects, as the lea-test strengths often go in a different direction to the ballistic test strengths.

On the whole, the ballistic test is considered to be the more reliable, and this will be taken as the basis of the following few notes:

In the first picking at Shendi, Delta Webber and Webber 38 did particularly well compared with either Pump Scheme strain or the control; Gendettu gave a medium result, and Pedigree Dixie, which was spun to a lower count than the rest, also did better than its control.

In the second picking the Pump Scheme strain had apparently deteriorated to such an extent that it was spun at the lower count along with Pedigree Dixie, which latter actually gave the better results according to the ballistic test. Of the remainder, spun to 42's, Delta Webber and Webber 38 were again the two best.

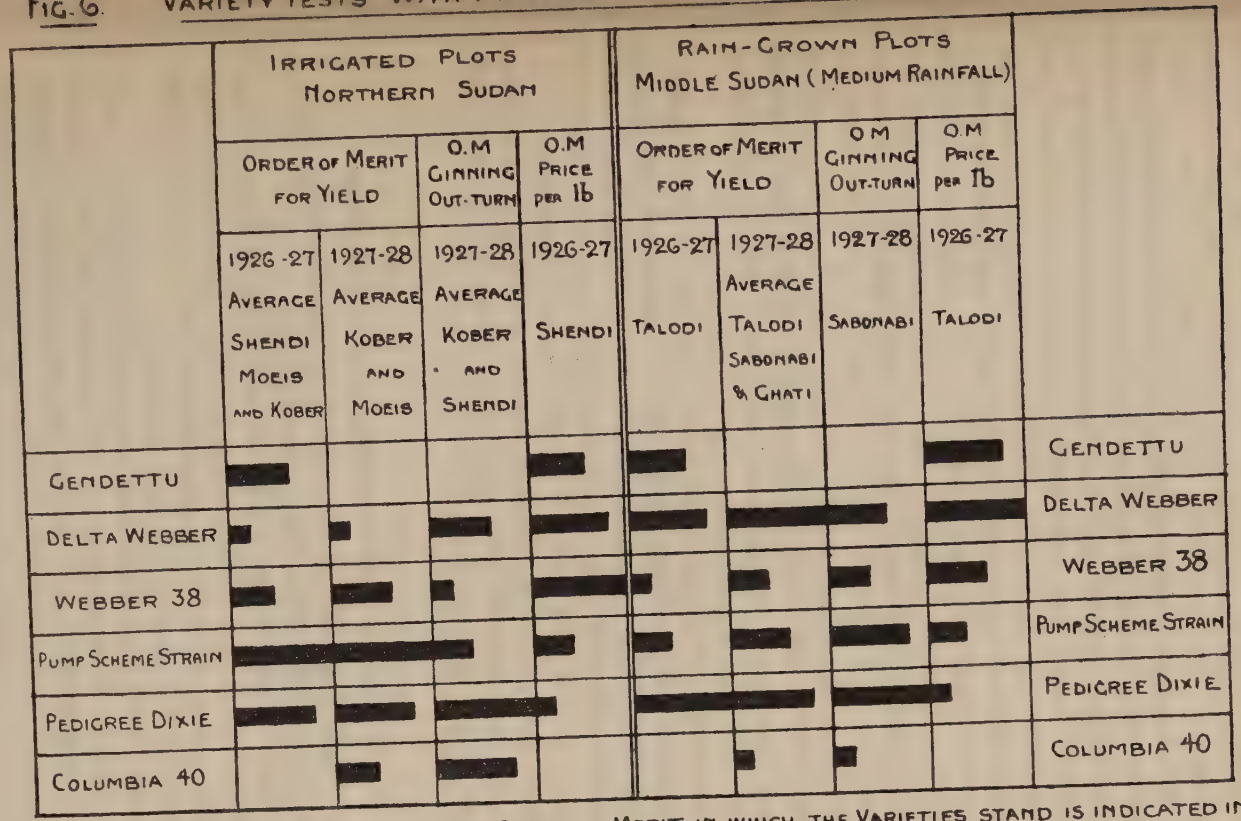
In the eighth picking from the same place, Pump Scheme was considered to be only worthy of a count of 24's. The rest were spun to 36's, Gendettu and Delta Webber being the two best.

At Talodi the best performance in the first and last pickings as regards strength was given by Gendettu. Delta Webber was only third best in the same pickings, being beaten by Webber 38. In the middle picking, however, this cotton and Webber 38 were specially selected for spinning to a higher count, and Delta Webber appears to have given the best results. Pump Scheme strain did just about as well as Delta Webber in the first picking samples, but was spun to a lower count in the middle picking, and gave the poorest result of all in the last picking.

Taken on the whole, yarn-strengths at Talodi were quite equal to, if not better than, those from the same varieties grown under irrigation. Earlier pickings, in both cases, are stronger than later ones, the samples from the eighth picking at Shendi, in particular, being easily the weakest.

The chief fault found with all these cottons lay in their neppiness, which was rather bad in practically every sample, the only exceptions

FIG. 6. VARIETY TESTS WITH AMERICAN COTTONS



IT IS IMPORTANT TO NOTE THAT ONLY THE ORDER OF MERIT IN WHICH THE VARIETIES STAND IS INDICATED IN THIS DIAGRAM. THE DEGREE OF DIFFERENCE IS NOT SHOWN. THE BLACK RECTANGLES ARE BUILT UP OF SQUARES ARRANGED HORIZONTALLY. FIVE SQUARES REPRESENT THE HIGHEST PLACE IN ORDER OF MERIT A SINGLE SQUARE REPRESENTS THE LOWEST PLACE.

being those of the first picking of Pump Scheme strain at Shendi and of the fourth picking of Gendettu at the same place, but these varieties behaved just as badly as the rest in the samples from other pickings.

It is felt that the data available for these cottons are too meagre to allow of an attempt being made to work out their actual value per unit area on the lines employed in dealing with the results of the Egyptian variety tests summarized above. In order, however, to enable some estimate of relative values to be made, Fig. 6 has been constructed from the " corrected " plot yields and from the graders' prices (corrected for grade), together with the rather scanty figures which we have for ginning out-turn. This table shows only the order of merit in each case, and not the degree of difference between varieties.

The commanding position, in all except price, occupied by Pump Scheme strain and Pedigree Dixie *in the irrigated plots* is clearly shown, whilst the all-round good performance of Delta Webber *in the districts of medium rainfall* is duly emphasized.

The variety Gendettu, when grown at Talodi, gave satisfactory yields, and, though not quite consistent in performance, the samples of this variety taken from that district gave particularly good results in the spinning mill, and the resulting yarns were well spoken of. Although this type is probably not so generally suitable as Delta Webber for conditions of moderate rainfall, it will be given further trial as it might possibly prove to be a very useful type of cotton for the wetter districts further south.

6. Developmental Observations on Cotton Plants.

(*a*) *Plants Grown in Boxes.*—Further studies have been carried out along the lines indicated in previous reports.

A complete year's series of soil-temperature records has now been obtained, with a view to determining how far the conditions under which the plant roots are growing in the boxes agree with those which occur in a normally irrigated cotton-field.

It was found that the surface temperatures (down to a depth of 10 cms.) in the boxes were, on the average, about 1° C. cooler than in the field alongside. At a depth of 20 cms. the temperatures ran together pretty closely during the period April-August, but from then on till December field temperatures appeared to be lower by 4° to 5° C., though during the other cool months of the year (January to March) the difference was on the other side. At 45 cms.

depth the differences between the monthly means for field and box rarely exceeded 2° C., but, again, were not constant in direction.

The conclusion, at present, must be that the temperature at depths below 10 cms. must have been affected by some factor, such as total moisture in the soil, which was not constant during the whole period, and that, by controlling this factor, it should be possible to get almost identical temperatures in both situations at all times of the year.

This season, three series of plants were grown, the seed being planted in mid-September, mid-January, and mid-March respectively.

The same features were noted as in previous years in regard to the production of the first fruiting branches. Plants sown in January succeeded in producing branches in positions as low as about the seventh leaf-axil on the main stem. March sowings gave an average position of two nodes higher up, and September-sown plants showed a further delay (twelfth axil).

As it had previously seemed likely that this phenomenon of suppression of the lowest fruiting branches during the hot season was primarily a soil-temperature effect, an experiment was arranged in which the soil in the interior of three of the boxes was cooled by a jacket of water, the water itself being cooled below air temperature, by evaporation through the outer wall of the container.

The temperature of the soil inside the boxes was thus lowered by 5° C. to 6° C. during the hottest period of the year. Despite this, the plants in these boxes behaved in a manner quite similar to that of the controls. It may, therefore, be taken that the temperature of the air, rather than that of the soil, is the deciding factor.

The most striking result in this season's series of cultures has been the effect of the exceptionally hot weather experienced during March and April, 1928. The plants sown in January produced their fruiting branches well down, at about the same nodal position as in the previous season, and flower buds began to be laid down along the branches in a normal manner.

The very high temperatures of mid-March, however, caused wholesale shedding of practically all buds, except those which had almost reached the flowering stage.

This behaviour is in marked contrast to that of the series of plants sown at a similar time in the previous season, which produced an excellent crop of flowers on the lower branches and continued to do so, until the " normal " hot weather, setting in in April, definitely put a stop to the production of more than an occasional flower.

(*b*) *Root Development and Soil Studies.*—Further series of cotton roots have been studied, special sowings being made in May for this purpose so that early development would take place during the hottest part of the year.

The main features of root development were similar to those noted during last year's work on plants sown in July and October. There was no observable limitation of root growth in the surface soil which could be attributed to unfavourably high soil temperatures, but, rather, an increase in the surface-rooting system as compared with the series previously examined. Varietal responses were slight, but similar in nature to those described in last year's report.

In order to be able to interpret the occurrences noted in root development studies, it has been considered advisable to get as much information as possible as to the character of the soil in the Experimental Farm down to a depth of at least 1½ metres. A considerable number of samples have therefore been taken at varying depths and in different sites on the farm. These samples are being examined in detail, not only by the methods of mechanical analysis, but also in relation to their salt-content, power of promoting capillary rise, moisture-content and wilting coefficients.

Interest still centres in the layer of hard, almost impenetrable, soil which normally occurs about half a metre below the surface. In order to gain some light on the nature and mode of origin of this layer, further soil samplings have been carried out in the neighbourhood of the farm, samples being taken (*a*) from the uncultivated desert, and (*b*) from certain areas on the Shambat Pump Scheme, which have only recently been put under irrigation, and which are known to give good yields of cotton.

In addition, a study has been made of the effect of growing cotton plants in boxes filled with soil taken from different depths.

These plants were grown under carefully standardized conditions of root-space, location, watering, etc., the soil being the only variant. They showed a marked preference for the soil taken from surface depths, making good healthy growth of normal character. On soil from the " bad " zone of middle depths the plants looked weak and unhealthy, whilst on soil taken from still greater depths (below the pan layer) they gave a fair growth, considerably better than that on " bad-zone " soil, but not so good as that on surface soil.

The changes were regular and progressive, and were similar in nature for both Sakel and American cotton plants.

(*c*) *Observations on Shedding.*—It is abundantly clear that very great wastage of crop occurs in this country through shedding

of buds or bolls. Differences appear to exist between varieties in the matter of susceptibility to influences likely to cause shedding, but, before these varietal differences can profitably be studied, it is necessary to determine the type of shedding which normally occurs and, if possible, the factors directly responsible for it.

With this in view, an experiment was carried out on lines as nearly as possible the same as those which had previously been employed in the course of similar investigations made in Egypt.

A long narrow calico trough was fixed between two rows of Sakel cotton growing on the Shambat farm. The trough was so arranged that twelve "holes" at normal spacing and containing two plants each occurred on each side of it. The trough was swept out carefully each day, and the number and size of all flower buds and bolls present was recorded. The number of leaves dropped was also entered up, and notes made as to the nature and force of the wind during the preceding period.

The experiment must be repeated in subsequent years before the results can be accepted as definite, but, for the moment, it may be stated that the following interesting indications have been obtained:

(i.) The period during the course of development of the flower buds during which susceptibility to shedding is greatest appears to be longer in this country than was found to be the case in Egypt, as indicated by the higher proportion of buds of *over* 5 mms. width which fall off.

When classified into sizes the following percentages of buds shed in the different classes were found to occur:

	Width in Millimetres across Bracteoles of Buds Shed.					
	0 *to* 5.	5 *to* 8.	8 *to* 12.	12 *to* 16.	16 *to* 24.	*Over* 24.
Percentage of total sheddings	44	28	11	8	8	1

(ii.) In this experiment no regular increase of shedding could be detected either just before or just after irrigation, such as might have been expected to occur if water-strain or waterlogging occurred.

(iii.) A slight resemblance is traceable between the shedding curves and the maximum temperature curves, when these are compared with a shift of five or six days between the two. It may be said that there is a bare indication that periods of relatively high

temperature at *any* season of the year are followed by increased bud-shedding five or six days later, especially when the humidity is low at the same time.

(iv.) The daily rate of boll-shedding shows very little relation to that of bud-shedding, and leaf-fall appears to be independent of either. Leaf-fall varied irregularly throughout the season, but in late December a general increase occurred, which lasted until the third week in January. This was doubtless connected with the stage of development reached by the plants, which were then entering into the quiescent phase. The temperatures at the time were running above the normal winter level, and it may be assumed that the plants had been in no way affected by cold. Daily fluctuations in the amount of leaf-fall, are, as might be expected, very much influenced by the occurrence of high winds.

7. Early Topping Experiment.

The considerations which led to the laying down of the experiment were explained in last year's report.

The somewhat favourable results obtained in the 1926-27 season from topping the plants one month after sowing made it desirable to repeat the experiment this year. A plot, two feddans in area, was used for the purpose, and was sown on August 15 as a single block of Sakel cotton.

Later, the field was divided up into fourteen beds of equal size. In four of these the plants were cut back one month after sowing, and in another four they were cut two months after sowing, the remaining beds being left untouched as "controls." Where topping was done, the plants were cut back in all cases to just above the third stem node.

The results obtained this time were decidedly against topping the plants, the final yields being as follows:

	Average Yield of Bed of $\frac{1}{8}$ Feddan.
Control	84 rottles.
Cut back 1 month after sowing	74 „
Cut back 2 months after sowing	34 „

The behaviour of the plants was rather interesting:—

The earlier-cut plants were about a month later in starting to flower than the controls, and the late-cut plants, naturally, were later still. Both the series which had been pruned, however, flowered very heavily when they had once got into their stride, but, as the season went on, the proportion of bolls opened to flowers

THE LABORATORIES, SHAMBAT, KHARTOUM NORTH.

Top Floor : Section of Plant Physiology and Pathology. Ground Floor : Plant Breeding Section.

1. South Front.

2. North Front.

PLANT BREEDING SECTION, SHAMBAT, KHARTOUM NORTH.

A Corner of the Main Laboratory.

Sudanese Assistants' Laboratories, Gin Rooms, Seed Rooms, Stores, Etc

produced dropped very rapidly indeed. The result of this was that the heavy crop of flowers produced in January in the late-cut beds gave rise to only a small fraction of the crop of open bolls which presumably would have been produced from the same number of flowers two months earlier.

The increasing virulence of Pink Bollworm probably accounts in large measure for the extremely low proportion of bolls brought to maturity in the case of these late flowers. In the absence of this pest, early topping would probably be a success.

The apparently favourable result obtained last year from this treatment may be explained by the abnormal behaviour of last year's crop in the *early* stages, due to a severe attack of Sudan Bollworm. This penalized the control beds to an undue extent and allowed the early-cut beds to show a lead, which would not usually be the case.

Conclusion.

In addition to the observations recorded above, various records and notes relative to the growth of the cotton plant have been made as time permitted, and, in particular, assistance has been given to the Government Botanist in compiling serial records on a special "Observation Plot" of Sakel cotton. The results from this plot will not be of interest until the record has extended over a series of years, and, in consequence, will not be dealt with in detail here.

In general, it is felt that definite progress has been made during the year towards supplying a type of cotton which will be specially suitable to the medium-rainfall zone of the Southern Sudan, and our efforts will now be directed towards selecting a type suitable for the conditions of the far South. As noted in the body of this report, the attempt to produce a type of cotton capable of supplanting, with advantage, the Sakel cotton now grown in the Gezira tract is likely to involve the use of hybrid types and will in consequence occupy a much longer period, though a start in this direction has been made.

(Included by courtesy of the Uganda Government.)

UGANDA

REPORT ON COTTON EXPERIMENTS, SERERE STATION, SEASON 1927–28

BY

G. W. NYE,

Cotton Botanist.

Season.

The 1927-28 season was very dry, especially during the planting months of June and July, which caused poor germination in many plots, and also in October when practically no rain fell at all. This lack of rain in October caused a great flush of flowers, and the highest peak of the flowering curves occurred in mid-October instead of the usual period in mid-November.

The following table gives the monthly rainfall compared with the monthly means of the last six years:

TABLE I.

Serere Rainfall.

Month.	*Precipitation 1927–28.*	*Mean Monthly Falls for Last Six Years.*
January	0·55	0·72
February	0·49	2·38
March	4·61	4·32
April	8·56	8·33
May	7·67	6·14
June	2·41	4·91
July	3·26	5·04
August	6·00	6·63
September	5·56	5·74
October	0·05	5·41
November	6·63	4·28
December	0·04	1·06
Total	45·83	54·96

The dry conditions during the critical months provided a very fine illustration of the drought-resisting powers of the cotton plant and the beneficial effect of constant stirring of the surface soil to prevent evaporation. Despite the dry weather, the main crop

at Serere yielded at the rate of over 500 lbs. of seed cotton per acre.

There were no serious attacks by insect pests. Jassids did some damage to a few susceptible varieties; stainers only appeared towards the end of the season, and then did very little damage; as a result of this the proportion of stained cotton was very low.

Very little damage was done by the Spiny Bollworm, and the serious attacks of a leaf and stem feeding beetle, *Syagrus rugifrons*, which had ruined many of the field trials in previous years did not recur.

Practically no disease damage except boll rots occurred; *B. malvacearum* attacked Sea Island and Egyptian plants, but was not much in evidence on ordinary cottons.

Selections.

A total of sixty-three strains were selected for growing in progeny rows, and most of this material consisted of re-selections from 1925-26 rows, and repetition of 1926-27 rows where seed was available. All the rows were planted on July 6, and germinated very badly owing to dry conditions after sowing. Where possible, blanks were filled in, and the resulting yields from the plot as a whole surpassed the most optimistic expectations.

Field observations and laboratory examinations were carried on as described in previous reports, over 40,000 bolls being examined in the laboratory.

The most promising result from these rows was the isolation of two strains which gave considerably lower boll-shedding rates than any other strain or variety. These strains—S.G. 23.8 and S.G. 21.5—both originated from single plant selections made in 1924 from the Nyasaland Upland variety; the former gave a boll-shedding rate of only 48 per cent. and the latter of 54 per cent. S.G. 23.8 is the most promising of the two strains, as it has large bolls and lint of good quality; it is being grown in a small bulk increase plot this year, and careful records will be kept to see if it retains its boll-retaining capacity. The flowering and bolling curves of these two strains are given at the end of the report (Figs. 3 and 4).

A strain, S.G. 35.10, a green seeded type selected from the Nyasaland, made remarkable vegetative growth, and gave a very high flowering rate, but its shedding of bolls was so high that practically no cotton was picked from it.

Several selections from Meade were grown, but this variety is unsatisfactory in this country as it has a very high rate of boll shedding and has very small bolls.

Three strains, B1, B2, and B4, from Bukalasa, did very well under drought conditions, and several sub-selections were made from them.

The S.G. 29 sub-selections were improvements on the parent strain, especially with regard to regularity of lint length.

A very noticeable feature in the progeny row plot was the increasing proportion of three-locked bolls as the season proceeded. There was also a considerable drop in weight of seed cotton per boll in the four- or five-locked bolls, chiefly due to the production of fewer seeds per boll.

In addition to the usual data obtained from these selections, counts were made of the number of undeveloped seeds per boll, as these no doubt assist in the production of neps. The proportion of undeveloped to normal seeds varies in different strains.

Table II. below gives a summary of the quantitative characters of some of the strains.

TABLE II.

Strain.	*Total Bolls per Plant.*	*Percentage Bolls Shed.*	*Loculus Number.*	*Seeds per Boll + Undeveloped Seed.*	*Weight of Seed per Boll (grms.).*	*Weight of Lint per Boll (grms.).*	*Lint Length (Mms.).*	*Lint Index.*	*Ginning Outturn.*
S.G. 15A	20·5	—	4·06	31·9 + 1·7	3·42	1·62	32·2	5·1	32
S.G. 44	17·6	—	4·08	31·9 + 2·3	4·06	1·61	31·8	5·0	28
S.G. 53	24·3	—	4·08	32·5 + 1·3	3·09	1·58	30·4	4·9	34
S.G. 2.10	34·9	60·0	4·02	29·9 + 1·6	2·99	1·47	30·1	4·9	33
S.G. 21.5	35·5	54·0	4·09	32·4 + 1·9	3·19	1·36	30·6	4·2	30
S.G. 23.8	35·1	48·0	—	32·0 + 1·6	3·29	1·77	29·3	5·5	35
S.G. 26.15	23·8	74·3	4·01	30·5 + 2·1	2·91	1·59	30·2	5·2	35
S.G. 27.7	28·2	58·6	4·06	31·9 + 2·0	3·29	1·70	28·8	5·3	34
S.G. 27·11	32·7	62·7	4·07	31·2	3·25	1·66	29·9	5·3	34
S.G. 27.15	30·8	61·7	4·03	32·3 + 1·6	3·20	1·69	30·3	5·2	33
S.G. 29.1	32·4	69·5	4·06	31·1 + 1·9	3.13	1·83	30·5	5·9	37
S.G. 35.10	38·2	72·0	4·15	31·3 + 3·5	3·05	1·59	31·5	5·1	34
S.G. 37.1	31·7	—	4·04	31·1 + 2·2	3·07	1·58	29·9	5·1	34
B. 1	48·4	65·0	4·06	31·9 + 1·8	3·68	1·66	32·7	5·2	31
B. 2	35·2	62·4	4·02	32·3 + 1·7	3·73	1·97	31·7	6·1	35
B. 3	38·9	—	4·04	33·2 + 1·1	3·19	1·61	30·3	4·9	34
B. 4	29·7	—	4·08	31·8 + 1·8	3·44	1·91	31·8	6·0	36

New Varieties.

Several new varieties were tried, including Arizona from North Rhodesia, Bancroft from South Africa and Mebane, Kasch and Acala from U.S.A. These all suffered badly from jassids and boll shedding

while their staples were below the required standard for this country. A few selections were made for keeping a small stock of seed.

The main problem confronting the cotton breeder in Uganda is still the production of pure lines of higher yielding capacity. The general quality of the cotton is very satisfactory, and if this is maintained by the higher yielding pure lines, part of the problem of benefiting the producer will have been solved. The Nyasaland Upland variety continues to give far and away better results than other types on most soils, but some of the other types under observation have shown indications of superior yielding powers on poor soils where the Nyasaland variety yields badly. S.G. 7, a strain selected from the variety Salsbury, is being tested on the poor, sandy soils of Usuku this year in a five-acre increase plot, and also in a variety trial. This cotton is shorter stapled, and has a harsher lint than Nyasaland, but it does well on poor soils, retaining its bolls better than N. 17.

Small Bulk Increase Plots.

Owing to the failure of the progeny rows last year, no material was available for small bulk increase plots, but one quarter-acre plot was sown with the S.G. 7 strain mentioned above for the purpose of building up a supply of seed for extended trials in Usuku. The poorest piece of soil on the plantation was chosen, yet the plot yielded at a rate of over 500 lbs. per acre. Practically no disease was observed, and the plants kept their bolls well. An analysis of bolls gave the following results:

Loculus Number.	*Number Seeds per Boll.*	*Seed Weight per Boll. (grms.).*	*Lint Weight per Boll. (grms.).*	*Lint Length. (Mms.)*	*Lint Index.*	*Ginning Outturn.*
4·21	31·08	4·03	1·83	27·7	5·8	31·2

The broker's report on a sample of lint from this strain reads as follows:

"Strict good middling, light creamy in colour. Staple good, $1\frac{1}{8}$", strong, rather wanting in fineness and lustre, 300 points on."

Medium Bulk Increase Plots.

Of the strains which had been grown in small bulk plots in the previous season, S.G. 29 was selected as being the most promising all-round strain, especially with regard to regularity and yielding

characters, and accordingly six acres were sown in July. Smaller plots of S.G. 15 and S.G. 26 were sown, the former on account of good broker's reports, and the latter as it came out on top in the spinning tests.

S.G. 29.—The plot of this strain was sown in July, and owing to very dry weather conditions after planting the germination was poor. Frequent resowings were necessary, but these also partially failed, the result being a very poor stand which looked even worse than it was, as the plot was spaced 5 by 2 feet owing to seed shortage. In view of the above facts, combined with the drought, the yield at the rate of over 800 lbs. per acre was extraordinary. The plants were very healthy throughout the season, and the cotton picked was very clean and pleasing in appearance. The produce was ginned commercially, and gave a ginning outturn of 31 per cent.

As usual a boll analysis was conducted, and the results are given in Table III. on next page.

The broker's report was as follows:

"Strict good middling, creamy colour, staple about $1\frac{3}{16}$", strong, silky and lustrous, 400 points on."

Subject to favourable spinning reports, it has been decided to push ahead with this strain as rapidly as possible, and this year 200 acres in three segregated plots are being grown, so that next year sufficient seed will be available to sow the segregated gombololas of Kadunguru and Labori.

S.G. 15.—This cotton has received good broker's reports, but adverse spinning reports, and further selections are being made within the strain. Two and a half acres were sown in July, and despite rather poor germination it yielded at the rate of 900 lbs. per acre. This high yield was unexpected, S.G. 15 having been regarded as a low yielder, as evidenced by previous variety trials.

The strain is very susceptible to jassid, and so noticeable was this that it was possible to pick out plots of it from a considerable distance in the variety trials at Serere and Bukalasa.

The broker reported as follows:

"Strict good middling, creamy in colour, staple full, $1\frac{3}{16}$", strong, silky and lustrous, 450 points on."

The results of the boll analysis are given below.

S.G. 26.—It had not been intended to grow this strain in bulk, but as it did well in the spinning tests, it was decided to put in one and a half acres in August. A perfect stand of plants was obtained, and the plot yielded at the rate of 850 lbs. per acre.

The broker's report is not very encouraging:

" Strict good middling, creamy colour, staple $1\frac{1}{16}$ to $1\frac{3}{16}$" irregular, strong, fairly lustrous and fine, 350 points on."

A plot of fifty acres is being grown this year by the C.M.S. at Ngora.

TABLE III.

Summary of Boll Characters of Medium Bulk Plots.

Strain.	*Loculus Number.*	*Number Seeds per Boll.*	*Weight Seed per Boll. (grms.).*	*Weight Lint per Boll. (grms.).*	*Lint Index.*	*Lint Length.*	*Standard Deviations of Lint Length.*
S.G. 29	4·03	31·5	3·30	1·86	5·9	31·0	2·01
S.G. 26	3·96	30·60	2·96	1·64	5·5	30·3	1·74
S.G. 15	4·04	30·2	3·58	1·61	5·3	35·3	1·94

Field Experiments.

Variety Trials.

Yield trials with one or more of the selected strains tested against the local strain were conducted in different parts of the country. No significant increases in yield were obtained. In the trial at Serere, records were kept on observation rows in each plot, the flowering and bolling curves of which are shown in the Appendix. The results of the rows are not confirmed by the total plot figures, as S.G. 27 gave a very much higher yield in the rows, but only the same as other strains in the plot yields. S.G. 15 is the lowest yielder in both plots and rows, its low yields being partly due to jassids.

Table IV. below gives a summary of all the trials, the results being the mean of five $\frac{1}{20}$-acre plots in each case.

TABLE IV.

Yields Expressed as Mean Lbs. Seed Cotton per Plot.

Site of Trial.	*N.* 17.	*N.* 19.	*S.G.* 15.	*S.G.* 29.	*S.G.* 27.	*S.G.* 26.	*N.*3/5.
Serere	45	44	34	45	45	47	—
Ngetta	29	28	—	28	30	—	—
Bukalasa	—	19	15	21	—	—	24
Kampala	—	4	4	8	—	—	3
Simsa	28	—	22	26	—	—	—
Labori	45	—	38	—	—	—	—

The Sowing Date and Spacing Experiment.

This experiment was continued at Serere and at Bukalasa on the same lines as those of the previous year with two additional spacings at Serere.

Serere.—The same plot was used as in the previous season, but the serious damage from rain wash did not recur on account of improved drainage and absence of many heavy falls of rain. A fair stand was obtained on most plots except some of the August sowings.

The closer spacings again did better than wide and normal (4 by 2 feet) spacings at all sowing dates. The success of close spacing for early sown cotton was possibly chiefly due to the dry weather, as in a normal year the production of much vegetative growth in early planted cotton annuls any effect of close spacing. Two plants left per hole again shows no increase whatsoever, which is no doubt due to the bushy type of plant which is common in Uganda. The June sowing gave a very definite increase in yield over both July and August, while July gave an increase over August.

The following statistically significant results were obtained:

June sowing:	3 by 1 foot	significant increase	over	5 by 2 feet.
					4 by 2 feet.
July sowing:	3 by 2 feet	„	„	„	5 by 2 feet.
					4 by 2 feet.
					3 by 1 foot.
August sowing:	3 by 2 feet	„	„	„	5 by 2 feet.
					4 by 2 feet.

June and July sowings gave significant increases over August at every spacing.

June sowings gave significant increases over July at 5 by 2 feet, 3 by 2 feet (2 per hole), and 3 by 1 foot.

For the purposes of the above the differences were only regarded as significant if they exceeded three times the standard error of mean difference.

Bukalasa.—Here again the earlier sowings and closer plantings gave better results. The standard error of the mean difference was much higher than at Serere. The first July planting gave significant increases over August planting at all spacings, except 4 by 2 feet, two plants per hole.

The results from both these experiments are summarized in Table V. on next page.

TABLE V.

YIELDS ARE GIVEN AS MEAN LBS. PER $\frac{1}{20}$-ACRE PLOT (EACH VARIATE BEING REPEATED FIVE TIMES).

Site of Experiment.	*Sowing Date.*	*Spacings.*						
		5 by 2 Feet (2 per Hole).	*4 by 2 Feet (2 per Hole).*	*4 by 2 Feet.*	*4 by 1 Foot.*	*3 by 2 Feet (2 per Hole).*	*3 by 2 Feet.*	*3 by 1 Foot.*
Serere	June 20	26	26	26	28	30	28	31
	July 18	20	24	21	25	24	28	23
	August 17	8	9	11	12	13	14	14
Bukalasa ..	July 15	—	30	27	43	—	45	44
	July 31	—	27	29	40	—	36	32
	August 31	—	24	18	26	—	25	26

Spacing Trials.—A number of small spacing trials were conducted in various parts of Teso and Lango districts. Apart from the comparisons of different spacings, the results afford a very good picture of the great variations in yield due to soil and climatic variations within small areas. Although close spacing does not give a significant increase in all cases, yet the balance is in favour of close spacing at practically every centre.

TABLE VI.

SUMMARY OF RESULTS FROM SPACING EXPERIMENTS. YIELDS GIVEN AS MEAN LBS. PER $\frac{1}{20}$-ACRE PLOT (EACH SPACING BEING REPEATED FIVE TIMES).

Site of Trial.		*Spacings 4 by 2 Feet.*	*Spacings. 3 by 1 Foot.*
Lango	Ngetta	38	40
	Kabermaido	41	54*
	Aduku	27	33*
	Dokolo	12	18*
Teso	Achuna	26	28
	Katini	19	20 (damaged by hail)
	Labori	45	44
	Tira	30	33
	Nyero	14	16
	Katakwi	10	11
	Kyere	26	24
	Simsa—N. 17	28	31
	Simsa—S.G. 29	26	26
	Simsa—S.G. 15	22	27

* Difference significant.

Sulphuric Acid Treatment of Seed.—Experiments on this treatment were continued, and the results from a small field trial were obtained. These results, together with those of previous years, have been summarized in a short paper,* and there is therefore no need to repeat them here.

Examination of Seed Cotton Samples from the General Crop.—As usual, numerous samples were received from the various cotton-growing districts in the Protectorate. Examination of these shows a satisfactory position where N. 17 seed has been introduced, though indications of its deterioration due to mixing and crossing are showing themselves. The staple of the crop shows a slight increase for the year, and is somewhat more regular.

Staff.—The writer was very fortunate in having the able assistance of Mr. Stephens during the rush period from October to February.

APPENDIX.

1. Flowering and Bolling Curves of Variety Trial. (Figs. 1 and 2.)

These curves are diagrammatic, but they serve to show the extraordinary flush of flowers brought on by the dry weather in October. The low yielding powers of S.G. 15 are well shown in these diagrams.

The first valley in the bolling curve appears to be due to the shedding of bolls during the extremely hot and dry weather of October; the second valley on December 21 is almost certainly due to the 3 inches of rain which fell in just over two and a half hours on November 17.

2. Flowering and Bolling Curves of S.G. 21.5 and S.G. 23.8. (Figs. 3 and 4.)

These two curves are of the two shedding-resistant strains referred to above. It will be noticed that although S.G. 21.5 produced more flowers, it has a lower bolling rate than S.G. 23.8.

* Published in Empire Cotton Growing Review, Vol. VI., No. 1, January, 1929.

FIG. 1 FLOWERING CURVES OF VARIETY TRIAL

FLOWERS PER PLANT PER DAY SMOOTHED TO 5 DAY MEANS.

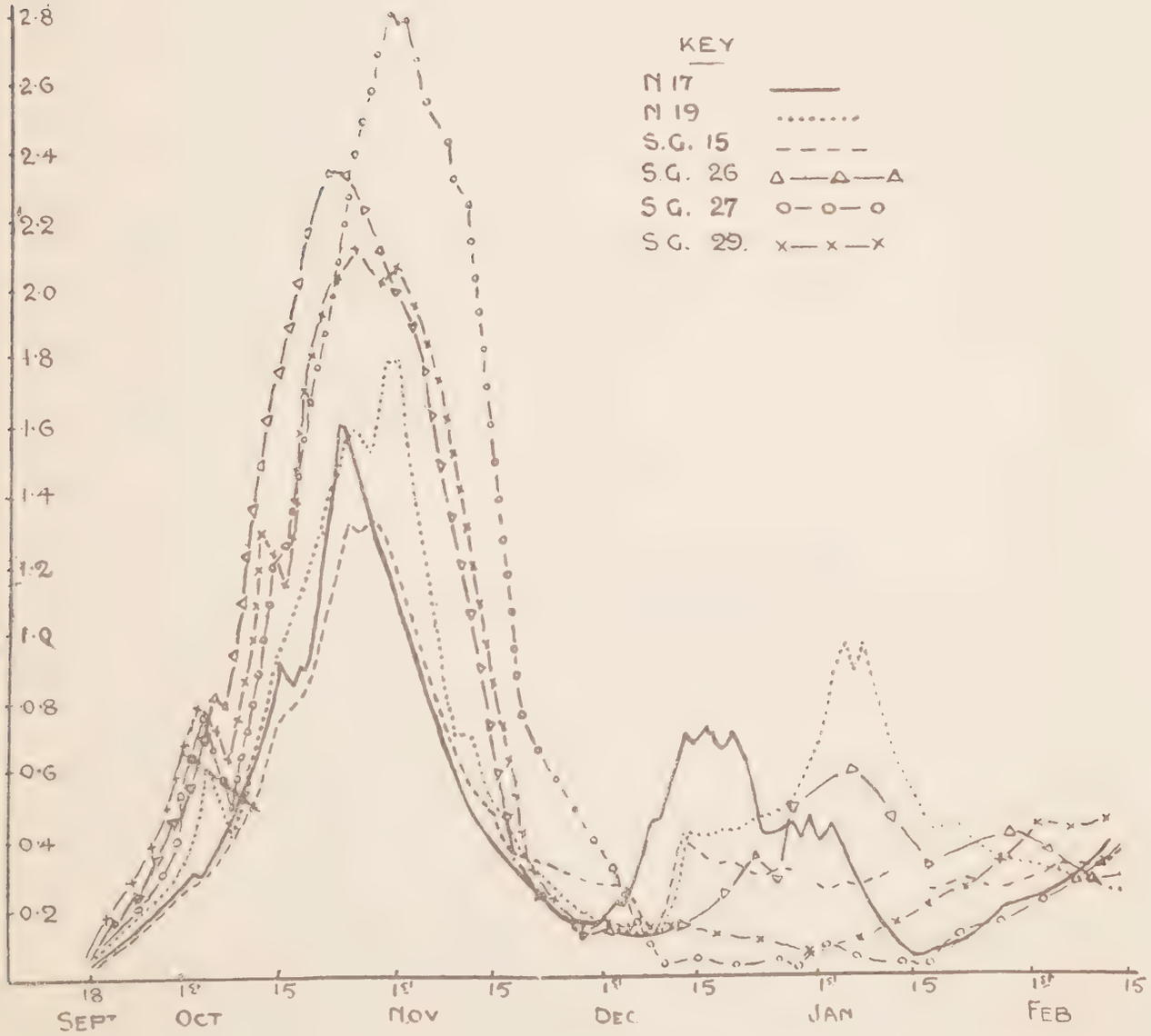


FIG. 2 BOLLING CURVES OF VARIETY TRIAL

BOLLS PER PLANT PER DAY WEEKLY PICKINGS

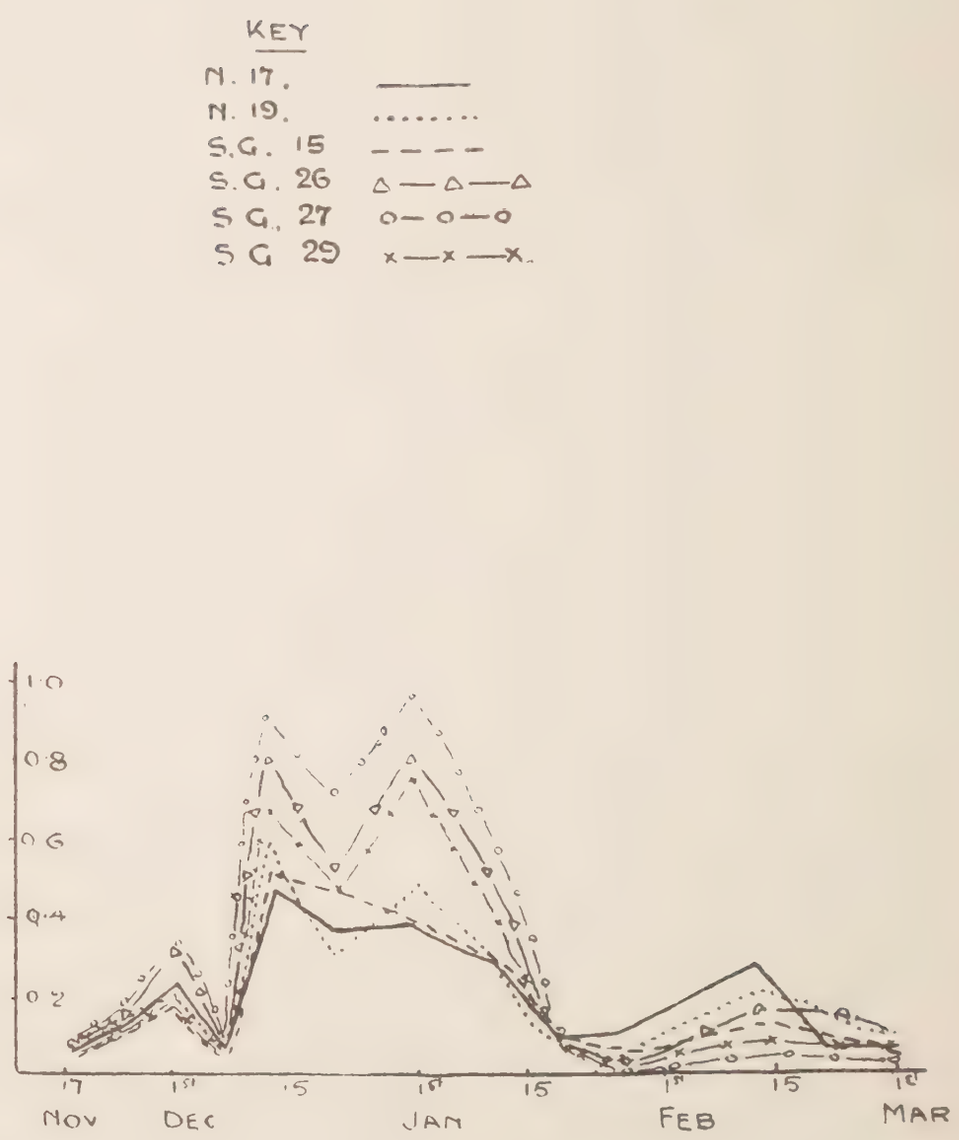


Fig. 3

Flowering Curves of Strains S.G. 23.8. and S.G. 21.5.
Flowers per Plant per Day smoothed to 5 Day Means

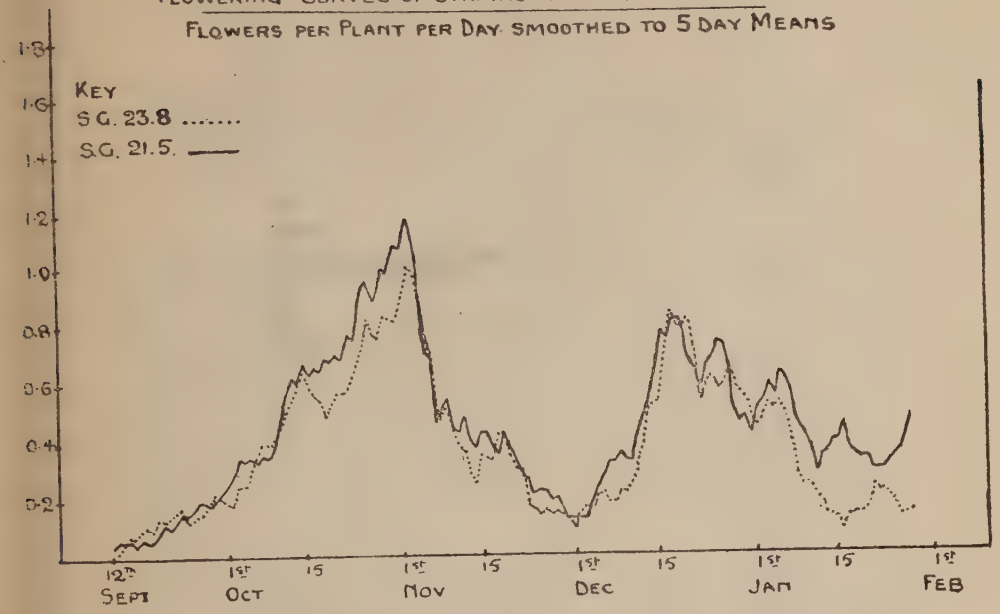


Fig. 4.

Bolling Curves of Strains S.G 23.8 and S.G. 21 5
Bolls per Plant per Day at 5 Day Picking Intervals

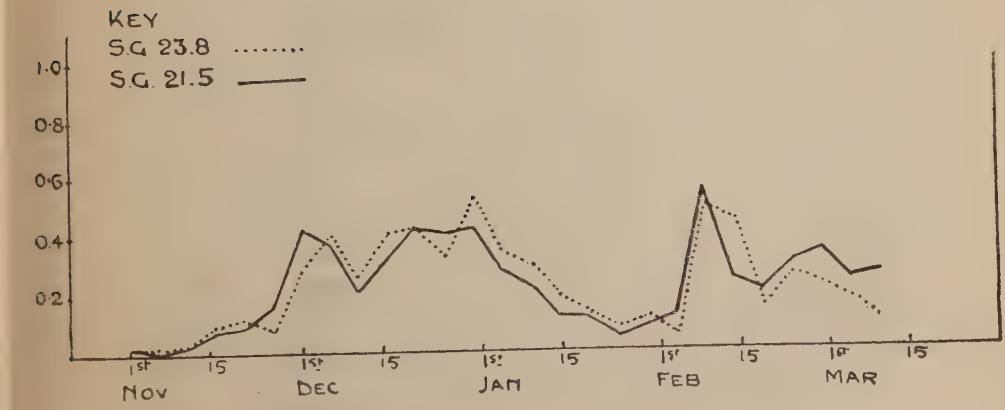
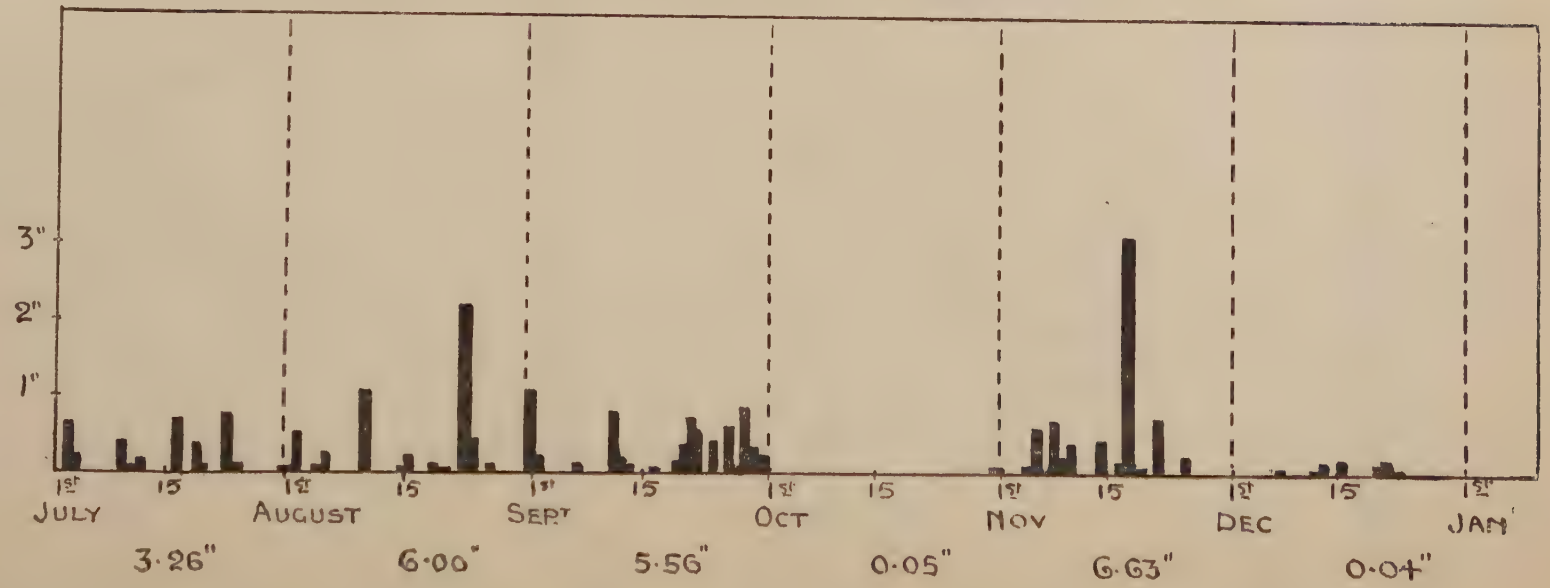


FIG. 5.

RAINFALL AT SERERE . JULY TO JANUARY 1927-28.



NYASALAND

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATIONS, SEASON 1927-28

Introductory Note by H. C. Ducker.

Staff During the Year.—Mr. Miller returned from leave in December and took charge of the Makwapala Station, Mr. Lochrie remaining there also until January to superintend the Cotton work. In January the latter proceeded to Port Herald to take over the Lower Shire Station from Mr. Lawrence, who was transferred to Makwapala.

The following report on Makwapala therefore records the joint work of the above-mentioned officers. Mr. Lochrie is responsible for the report on Port Herald.

The outstanding feature of the year is a clearer realization of the jassid problem, so far as Nyasaland is concerned. At Makwapala this has resulted in the discarding of several seed stocks of doubtful value and the acquisition of several new and promising lines. It has also been of value in selecting naturally the best Over-the-Top sub-strains. At Port Herald the breakdown of the Foster Whitehall strain G in the time-of-planting experiment has been of the utmost value in pointing out the weaknesses of a jassid-susceptible strain under Lower Shire conditions. Apart from the Stations, a considerable area of test plots was grown both by natives and Europeans, and some very gratifying results obtained. Over-the-Top B was the main variety tested, and the average yield of the various plots taking the country as a whole is about 400 lbs. seed cotton per acre. This is very satisfactory, being nearly twice the usual Nyasaland Upland yield. Several plots have yielded in the neighbourhood of 200 lbs. lint per acre, and one, the exact figures for which are not yet to hand, is reported to have given 300 lbs. lint per acre.

Chief Simon at Lisungwe, Central Shire area, has had another good year, and from the 50 lbs. seed originally supplied to him he has some 6 tons available for sowing this season. There are also available for sowing at least 6 tons more in the Domira Bay-Bwanje Valley-Balakas area, and it is hoped that there will be enough seed this next year for the whole country other than the Lower Shire.

MAKWAPALA COTTON STATION, REPORT FOR THE SEASON 1927-28

BY
H. C. DUCKER.

Season.—This season can be described in brief as a good one spoilt. The rains broke early and were very well distributed throughout the year from the point of view of crop growth, and though shorter than those of last season by some 5 inches, it cannot be said that at any time the cotton crop was in serious danger from drought.

The season was spoilt by an increased amount of rain in March, followed by spells of dull drizzly weather which extended, with fine intervals, from about March 16 to mid-April.

Up to March 16 there had been nothing more than normal boll-worm attack, which had left what promised to be a very fair cotton crop. With the onset of the dull weather stainers came in gradually increasing numbers, reaching their maximum about April 10. To them is due the damage suffered by the crop.

The cold weather, as indicated by the drop of the minimum thermometer readings to below 60° F., set in at a more normal time than last season, about May 5.

General.—The work of the Station has continued on lines similar to those of the past two seasons.

The rotations have been carried on into their fourth year with but minor modifications made to the programme indicated in the 1926-27 Report. The tobacco-curing barns and the bulking and grading shed were completed in time for the harvest of this crop, and have proved suitable for their purpose.

Serious labour difficulties arose in January, due, in large measure, to the extended employment by various estates of Ganya* labour at boom wages, and aggravated considerably by anxiety on the part of the natives regarding their food crops. Fortunately the food supply situation turned out to be far less serious than was at first thought, and it is probable that the break in tobacco prices will prevent any repetition this season of the difficulties arising from the extensive employment of Ganya labour.

Fortunately, with the aid of bullock cultivators and the few natives resident in the native lines on the Station, it was found possible to save the cotton crop from being swamped by weeds, and though the

* Labour employed by the day for money and/or food. Labour is usually employed by the month.

cotton, and in particular the rotation crops, suffered somewhat from want of sufficient cultivation, no serious damage was done.

In view of the considerable advantage to be gained from having labour resident on the Station, it was decided after this experience to build lines in the same fashion as at Port Herald. It was decided that it would be possible with a surplus of bricks from the building done last season, and with an economical design of hut, to meet the cost from the sum authorized for recurrent expenditure. A sufficient number of huts to house all the Station labour is at present nearing completion. They have been built with burnt brick foundations, green brick walls, and roofed with thinnings, taken from the *Cedrela toona* plantation, and grass thatch. They promise to be decidedly popular.

In addition it has been decided to start stocking the Station with implements more suited to the labourer's mentality than those in use hitherto. What most decidedly seem to be required are simple implements, which can be used with one or two pairs of bullocks, and which are not easily broken, either in the course of their work or by the operator when he wants a rest; and they should be so designed that parts likely to be broken are easily replaced from stock. As little wood as possible is greatly to be desired in the designs. A commencement in a small way has been made with the introduction to the farm of simple tine cultivators of U.S.A. designs, and of a plough, Ransome's Sabul, recommended by Mr. Milligan when he visited Makwapala. Both have done excellent work.

The whole Station was ridge-terraced during the 1927 dry season, and the new ridges have been well tested by a heavy fall in December, followed by other deluges during the rainy season. Only two minor breaks occurred, and it may be said that the problem of soil erosion at Makwapala has been solved. Various improvements are being made to the terraces this coming season, and at Mr. Milligan's suggestion a method of stone breakwaters is being tried in the two main drains which have continued to give trouble. It is expected that these, with the aid of the Napier fodder grass which has proved so useful as field borders, etc., may render these drains effective in checking further erosion and allowing silting up to occur.

The cotton work has continued on lines similar to those of past seasons. The continuous records have been elaborated in so far as their study of the insect pest incidence is concerned. Plant-breeding work has been carried on as before, and has been simplified by a heavy jassid infestation, which has made possible the discarding of a number of strains of doubtful value.

Two new introductions were made from South Africa, U 4 and A 12, which were kindly supplied to us by Mr. Parnell, the Corporation's Plant Breeder at Barberton, Transvaal. These promise to be of considerable interest and value to Nyasaland.

Rotations.—Apart from difficulties already mentioned in connection with the labour, and the consequent lack of cultivation, there is hardly any feature of particular interest about the rotations themselves which has not been dealt with in previous reports. The only exception is the complete failure of *Dolichos lablab* from the attacks of insect pests, in particular a leaf-eating Chrysomelid, on the first sowings in December, and the common bud-eating Bruchid beetle mentioned in last year's report, on the later sowings which were tried. This bean, never very popular in the native gardens, is being discarded, though any new varieties obtainable will be tried in the hope of reinstating it in the station's cropping schemes.

The cropping scheme for this season was as follows:

	Field.		*Field.*		*Field.*
Rotation I.	Cotton	1	Cereals	10	—
„ II.	Tobacco	2	Cotton	11	Cereal-pulse 12
„ III.	Tobacco	3	Cereal-pulse	12	Cotton 7
„ IV.	Cereal	4	Cotton	5	Fibre-oil seeds 6

The really important thing about this season's work in this connection is that all the indications are in favour of the rotations being sufficient to control bollworms sufficiently to permit of a reasonable cotton crop being made, with, of course, the aid of a suitable variety. Given jassid-resistance and a reasonable state of soil fertility on the Station, which latter will be assured with the aid of the anti-erosion measures and improved cultivation, the fundamental difficulty is likely to prove to be stainers and their control.

Field Experiments.

Part of Field 11 and part of Field 7 were used for plot experiments: Field 11 for spacing, and ridge and flat experiments as in Field 2 last season, and Field 7 for a variety trial of Nyasaland Upland and Over-the-Top B. The balance of Field 7 and the whole of Field 11 were sown to Over-the Top B.

Last year's results were somewhat inconclusive, and in an effort to remedy this the plot layout was modified so as to suit ridge-terraced ground. The same plot arrangement was used, but the replicates were increased in number to eight pairs of half-drill strips. The plots were surrounded by a bulk treated in the same way as the control plots, which were the same as last season—*i.e.*, Over-the-Top

sown at 4 feet by 2 feet on the flat, one plant per hole. This gave the arrangement S V V S S V V S S V V S S V V S surrounded by S, where S is the control and V the variable. The rows were arranged to run at right angles to the ridge terraces, and each series fitted in between a pair of ridge terraces.

The results obtained were as follows:

Field 11, *Spacing Experiments.*—The control in each experiment was a spacing 4 feet by 2 feet, one plant per hole.

A. Four feet by 2 feet, two plants per hole. The mean difference in favour of the two plants per hole spacing was 1·06 lbs. of seed cotton and its standard error 0·522 lb. The difference, being only 2·03 times its standard error, is unlikely to be significant.

B. Four feet by 1½ feet, one plant per hole. Mean difference 0·34 lb. in favour of the 1½ feet spacing. Standard error of mean difference 0·405 lb. The difference is decidedly not significant.

C. Four feet by 1 foot, one plant per hole. The mean difference being 2·74 lbs. with a standard error of 0·595 lb. is 4·60 times the standard error; the result in favour of the 4 feet by 1 foot spacing is almost certainly significant.

D. Four feet by 6 inches, one plant per hole. The mean difference, 1·92 lbs., is 3·86 times its standard error, 0·498 lb., and is almost certainly significant, though less definitely so than in the case of the results of the 4 feet by 1 foot spacing.

These results are of considerable interest, though a greater range of spacings should have been tried. This will be done in the coming season, when a range from 6 inches to 1 foot 6 inches will be tried, differing by 3-inch intervals. What is wanted is a spacing sufficiently dense to give the maximum fruitage per acre that the fertility of the soil will allow, and arranged in such a way as to give the least shade and shelter to the various insect pests. These ideals are unobtainable together, but from observation of the behaviour of cotton under the spacings which have been tried, it would appear that single plants per hole at a moderately close spacing will be found the most suitable for row cultivation of cotton.

An important observation made was that the two closer spacings, which gave the greatest increases over the control plots, gave their largest pickings earlier than did the wider spacings.

"Ridge and Flat" Experiment.—The ridge-sown cotton gave earlier and heavier pickings than did that sown on the flat, and its superiority is most definitely marked in the figures. The mean difference in its favour is 2·69 lbs., and the standard error is 0·522—*i.e.*, the difference is 5·15 times its standard error.

Under this season's conditions the indications are strongly in favour of an early crop being the best from the point of view both of yield and quality, and it would appear that increasing the acre density of plants and forcing the crop on to earlier maturity by ridging are both measures of value to the cotton-grower, provided that bollworm control through rotation of crops continues to prove reasonably efficient.

Observations made on the "Ridge and Flat" and "Spacing" Plots.—As noted last season, there was but little observable difference between the ridge and flat plots in appearance. Both remained equally green and healthy, while there was but little to choose between them as regards plant development. As last season, the plants on the flat grew slightly taller than those on the ridge. The earliness of the ridged cotton was most marked, and from the evidence of the continuous records made on the variety test plots it would appear that this is the reason for the superior yield. An interesting point in connection with this experiment was that the plants on the ridge were much less badly laid than the plants on the flat, an observation quite contrary to preconceived ideas on this subject.

The records obtained so far are as follows: 1926-27, a slight significance in favour of the *flat* planting; 1927-28, a decidedly significant superiority on the part of the *ridged* cotton. The experiment is to be repeated this season in Field 11.

The spacing experiments are chiefly of interest in that they confirm, for this season's conditions, the conclusion reached in regard to the "ridge and flat" experiment, that the earliest cotton is the best. Last year's results (1926-27) with these spacings were inconclusive, and the experiments are to be repeated in a modified form this coming season.

The two plants a hole arrangement again showed to disadvantage in that the plants tended to fall apart, making a tangled mass in the centre of the rows. This gave more cover to stainer, and it was observable in this connection that the two plants per hole plots showed a larger proportion of stained cotton.

Plot Layout.—It would appear that a satisfactory type of arrangement has now been found for the plots in the eight times replicated half-drill strip. The standard error of the standard errors of the five sets of plots in Field 11 is only 0·01, with the mean difference between the standard errors 0·004; the latter, therefore, shows no significance. Last season the standard error of the standard errors was nearly as great as the mean standard error itself, and the latter could in consequence have no meaning.

In this season's experiments, the arrangement of the plots between ridge terraces, instead of on land exposed to wash, and the doubling of the number of plots, has given sets of results free from wide fluctuations and thoroughly comparable between themselves.

Table I. gives the figures obtained from the various sets of plots in field 11:

TABLE I.

A. 4′ × 2′ two plants *v* 4′ × 2′ one plant.
Differences A – S in lbs.
+3·43 +0·13 +1·94 +3·20 −0·62 +0·62 −0·88 +0·62.
Mean difference +1·06 lbs.; standard deviation ∓1·534 lbs.; standard error ∓0·542 lbs.

B. 4′ × 1′6″ one plant *v* 4′ × 2′ one plant.
Differences B – S in lbs.
+0·12 +1·99 −0·88 +0·62 −1·13 +0·68 −0·69 +2·00.
Mean difference +0·34 lbs.; standard deviation ∓1·145 lbs.; standard error ∓0·405 lbs.

C. 4′ × 1′ one plant *v* 4′ × 2′ one plant.
Differences C – S in lbs.
+4·63 +3·00 +0·68 +3·51 +2·44 +5·38 +0·07 +2·25.
Mean difference +2·74 lbs.; standard deviation ∓1·69 lbs.; standard error ∓0·595 lbs.

D. 4′ × 6″ one plant *v* 4′ × 2′ one plant.
Differences D – S in lbs.
+4·19 +3·30 −0·06 +2·81 +0·19 +1·25 +1·26 +2·44.
Mean difference +1·92 lbs.; standard deviation ∓1··41 lbs.; standard error ∓0·498 lbs.

R. Ridge *versus* flat at 4′ × 2′ one plant per hole.
Differences R – S in lbs.
+3·13 +4·69 +3·50 +3·76 +0·56 +3·87 +0·94 +1·13.
Mean difference +2·69 lbs.; standard deviation ∓1·475 lbs.; standard error ∓0·522 lbs.

Variety Trial.

The variety trial made last year, using Over-the-Top B and Nyasaland Upland (Lisungwe strain), was repeated in Field 7. The eight replicate type of plot layout was used as in Field 11, and the set of plots fitted in between the second and third ridge terraces on the west side of the field. These ridge terraces were only made last year, while those in Field 11 were two years old. Conditions were, therefore not quite so regular as in Field 11, but even so fairly level results were obtained. Two groups of fifteen plants each were taken from the middle row of each strip for purposes of continuous records. The balance of the plot was harvested by means of weekly pickings as for the Field 11 plots.

The following results were obtained:

TABLE II.

V – S in lbs., where V is Nyasaland Upland and S Over-the-Top.
Differences:
+0·50 –7·50 –0·50 –1·50 –2·50 –5·00 –4·00 0·00.
Mean difference –2·56 lbs.; standard deviation ∓2·59 lbs.; standard error =0·915 lbs.

It will be noticed that the standard deviation and standard error are appreciably more than (nearly double) the standard deviations and errors in the Field 11 sets of plots. It seems probable that this may be in part due to the relative lack of uniformity of the soil due to the delay in ridge-terracing this field.

The mean difference is 2·80 times its standard error, and may possibly be significant. Last year there was no significant difference between the final fields of these two strains. The indications, however, given by the general appearance of the two strains and the results from the test-distribution plots of last year and this year, indicate that Over-the-Top is the heavier cropping strain.

It seems highly probable that this is due, at least in part, to its superior resistance to jassid. Both strains are reasonably resistant to jassid, but the Over-the-Top is undoubtedly the superior under the Makwapala conditions.

Continuous Records.—These were made on the centre row of each strip, as described above. The following records were kept:

(*a*) Flowers per plant per day.
(*b*) Bolls per plant per picking (bi-weekly).
(*c*) Shed material per plant per day.

Analyzed into:

(1) Buds and flowers due to Bollworm.
(2) Buds and flowers not due to Bollworm.
(3) Bolls due to Bollworm.
(4) Bolls not due to Bollworm.

(*d*) Growth in centimetres measured weekly.
(*e*) Weekly collection of bollworm-infested material and analysis of bollworms into species.

It was attempted at first to subdivide the losses not due to bollworm into those due to stainer and those not due to stainer, but it was found impossible to do this with any exactness owing to continual finding of doubtful cases.

(*e*) was made from the adjacent bulk as last season and the collection analyzed in the laboratory.

It will be noted that the method whereby study of the daily bollworm infestation was made has been altered to a study of shedding loss. This is in accordance with the general principle now adopted at Makwapala of giving the pests free scope in so far as the environment will allow them to develop. Their status now, so far as the Station's work is concerned, is that of indicators, it being thought that in general they are to be regarded as an effect associated with, rather than a cause of, crop failure.

Daily pickings of infested material led, of course, to what might have been a partial control of bollworm damage.

Flowering Curve (*Fig.* 1).—This agrees closely with that of last season, the Nyasaland Upland being almost throughout higher than the Over-the-Top. The plants were not left on the ground long enough to show the second flush phenomenon, but some patches of Over-the-Top B which have been left as trap crops in various parts of the Farm are at the time of writing carrying a few bolls which will open shortly. Generally speaking, it would appear from observation at the Station and elsewhere that anything other than the main flowering is comparatively useless from a cropping point of view, except, perhaps, in the Lower Shire area. In this area, however, it is better to sow later so as to have the flowering reaching a maximum when the insect pests have reached and passed their zenith, as was clearly shown at Port Herald last season. All that happens when cotton is sown early is that in most seasons the first flush is completely lost and the second flush suffers from lack of moisture, which would, of course, be saved by fallowing before sowing the late-planted crop. The nearest area in type to the Lower Shire is the Lisungwe area of the Upper Shire, and here it is strongly held by the growers that early planting is usually the best, while not much is expected from any second flush which may occur.

There does not appear to be much difference in earliness between the two strains.

Bolling Curve (*Fig.* 1, *Inset*).—Losses between flowering and bolling are again very high, as was noted last season; Nyasaland Upland loses more in proportion. The difference in favour of the Over-the-Top is possibly significant, being 7·13 bolls per group observed with a standard error of ∓2·46 bolls.

Loss Curves (*Figs.* 2 *and* 3).—Losses from shedding of buds and flowers (Fig. 2) are almost entirely due to bollworm, the small loss from other causes being practically all natural shedding, so far as could be ascertained. Nyasaland Upland loses most in numbers of forms. Losses of buds and flowers are of little importance before

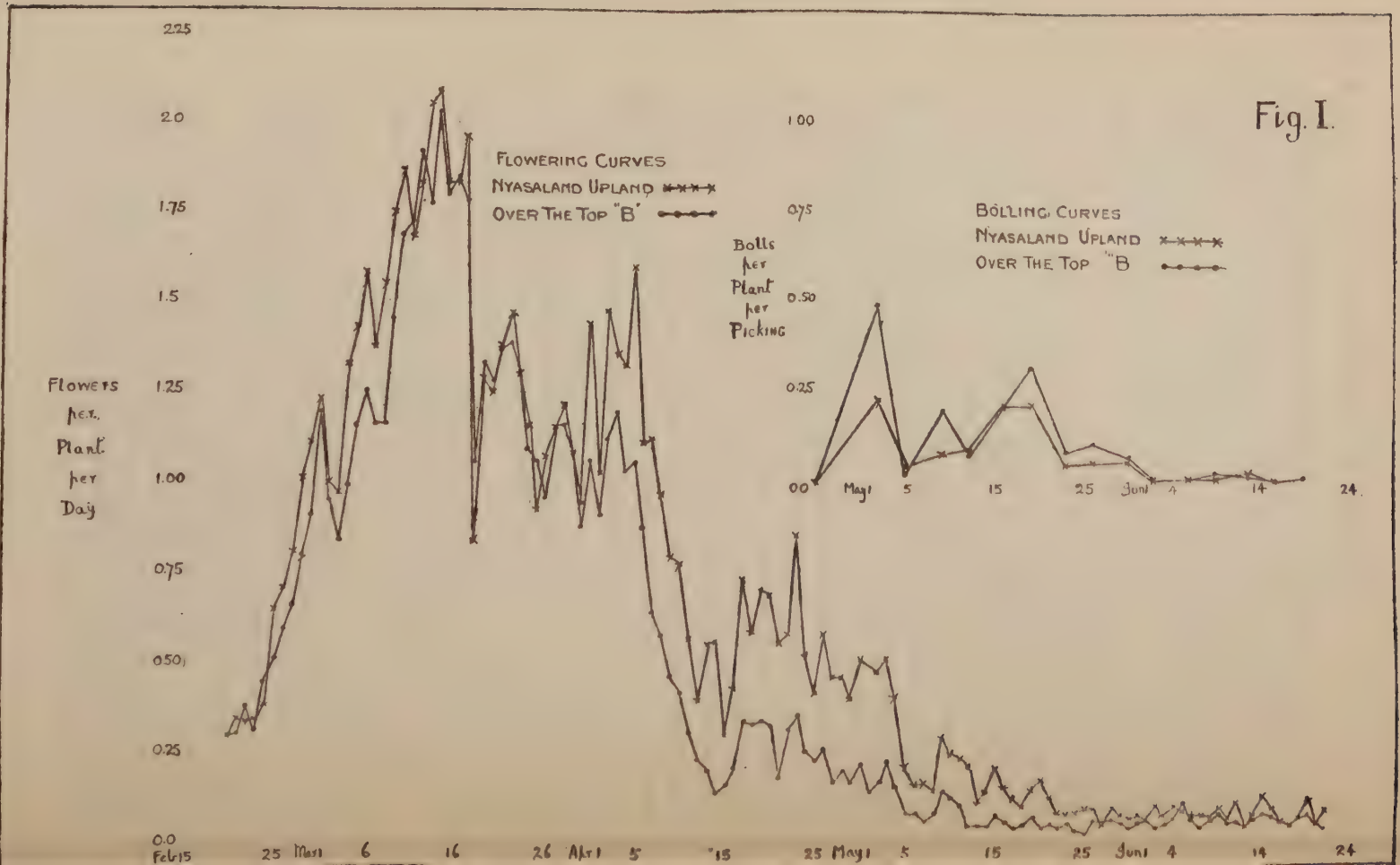


Fig. I.
Flowering Curves
Nyasaland Upland
Over the Top "B"
Bolling Curves
Nyasaland Upland
Over the Top "B"
Flowers per Plant per Day
Bolls per Plant per Picking
2.25
2.0
1.75
1.5
1.25
1.00
0.75
0.50
0.25
0.0
1.00
0.75
0.50
0.25
0.0
Feb 15
25 Mar 1
6
16
26 Apr 1
5
15
25 May 1
5
15
25 Jun 4
14
24

March 6 or after April 5, and it will be noted, on reference to Fig. 3, that this period also covers the major loss of bolls through bollworm.

The really important point of these records is the loss of bolls from causes other than bollworms, during the period March 16 to May 15. This loss was almost entirely attributable to stainer damage. Relatively speaking, it is greatest in the Over-the-Top as compared with Nyasaland Upland, though not significantly so. Compared with the bollworm loss it is relatively greater in Over-the-Top than in Nyasaland Upland, though with both strains it is a greater source of loss than is bollworm.

Last year, except for a short period in March, loss from bollworms was most decidedly the more important, but the failure, this season, of Makwapala to equal last year's average yield must be attributed to stainer damage. An examination of the humidity (wet and dry bulb) and rainfall curves in Fig. 4 is of decided interest as compared with last season's records. March this year has been wetter than March last year, and in addition a succession of cloudy dull spells occurred between March 16 and April 21 of durations varying from two days to a week. To this is undoubtedly due the heavier stainer infestation. Reference to the non-bollworm loss curve of Fig. 3 will show that the stainer loss clearly commenced with the onset of this inclement spell. Last year such rain as occurred was mainly in the form of showers followed by bright intervals, and at no time were stainers of real importance.

Whether attempts at direct control of stainer by trapping or similar measures are likely to be of use in the future is doubtful. The indications from the results of the spacing, and ridge and flat experiments are that an early crop has the best chance of coming to a satisfactory maturity under this season's conditions. It may be noted that these conditions may be taken as generally typical of Nyasaland conditions as represented by Makwapala; 1927 was decidedly exceptional.

It does not appear improbable that such differences as exist between Over-the-Top and Nyasaland Upland in their reaction to bollworm and stainer attack are to a great extent bound up with their relative resistance to jassid. The greater shedding losses of the Nyasaland Upland would certainly indicate some such connection.

Growth Records.—These (see Fig. 5) show no features of particular interest as compared with last year's records. They are confirmatory in showing that with these strains no effective growth takes place after the end of April. Cessation of growth is again associated with the drop of the minimum temperature below 60° F., though, as was

Fig II.

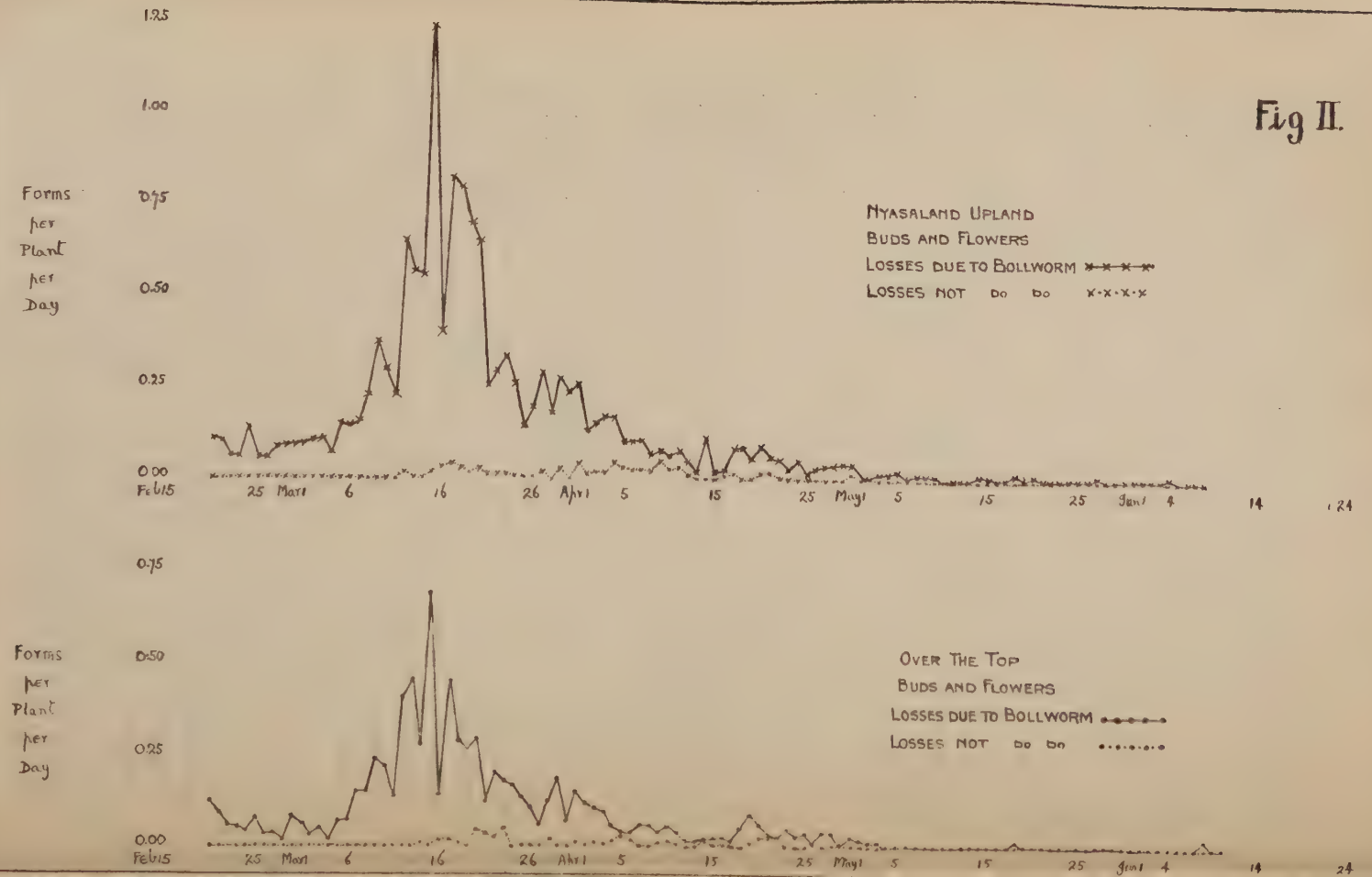
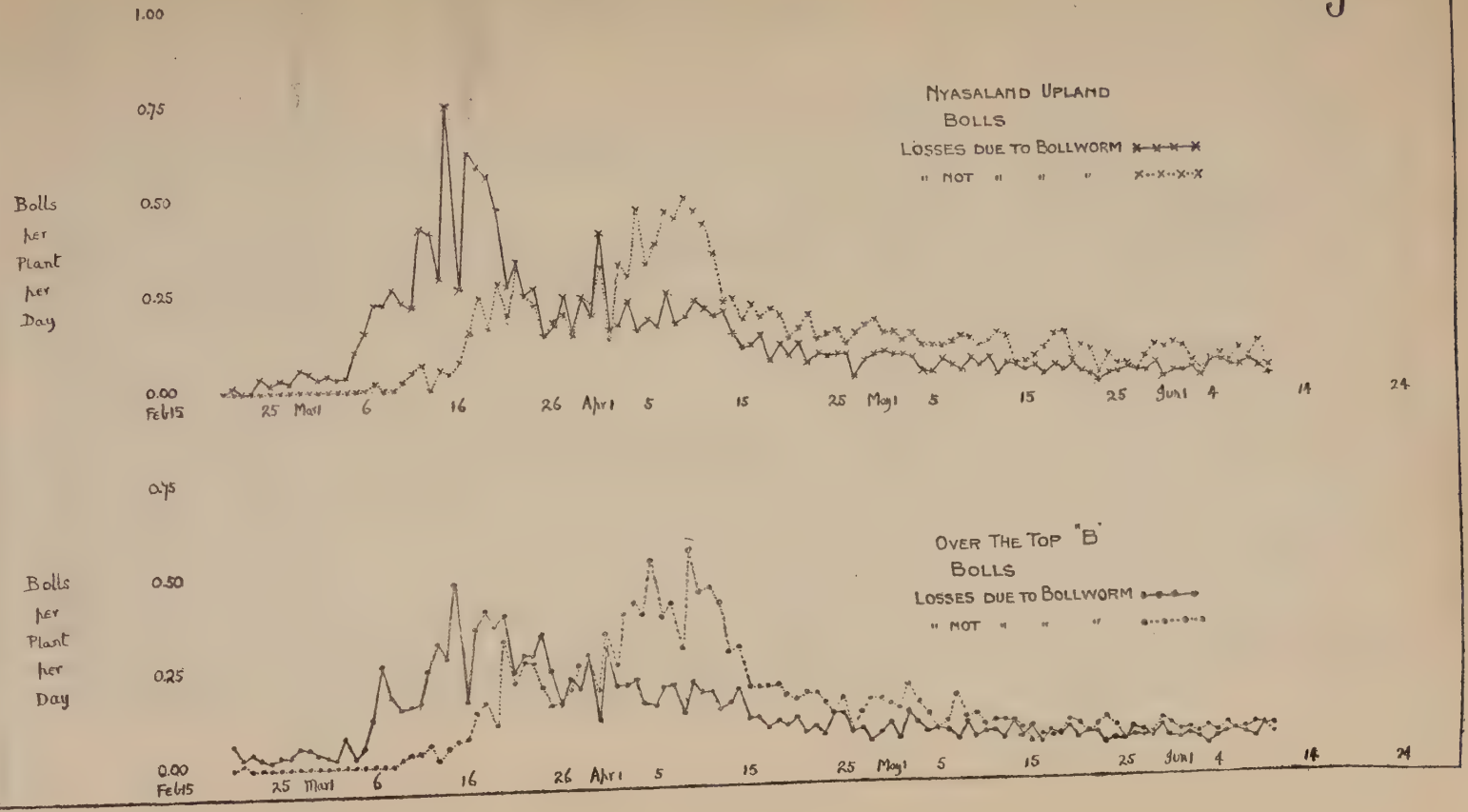

1.25
1.00
0.75
0.50
0.25
0.00
Forms per Plant per Day
Feb15
25
Mar1
6
16
26
Apr1
5
15
25
May1
5
15
25
Jun1
4
14
24
Nyasaland Upland
Buds and Flowers
Losses due to Bollworm
Losses not Do Do
0.75
0.50
0.25
0.00
Forms per Plant per Day
Over The Top
Buds and Flowers
Losses due to Bollworm
Losses not Do Do

Fig III


1.00
0.75
0.50
0.25
0.00
Bolls per Plant per Day
Feb15
25 Mar1
6
16
26 Apr1
5
15
25 May1
5
15
25 Jun1
4
14
24
NYASALAND UPLAND
BOLLS
LOSSES DUE TO BOLLWORM
" NOT " " "
OVER THE TOP "B"
BOLLS
LOSSES DUE TO BOLLWORM
" NOT " " "

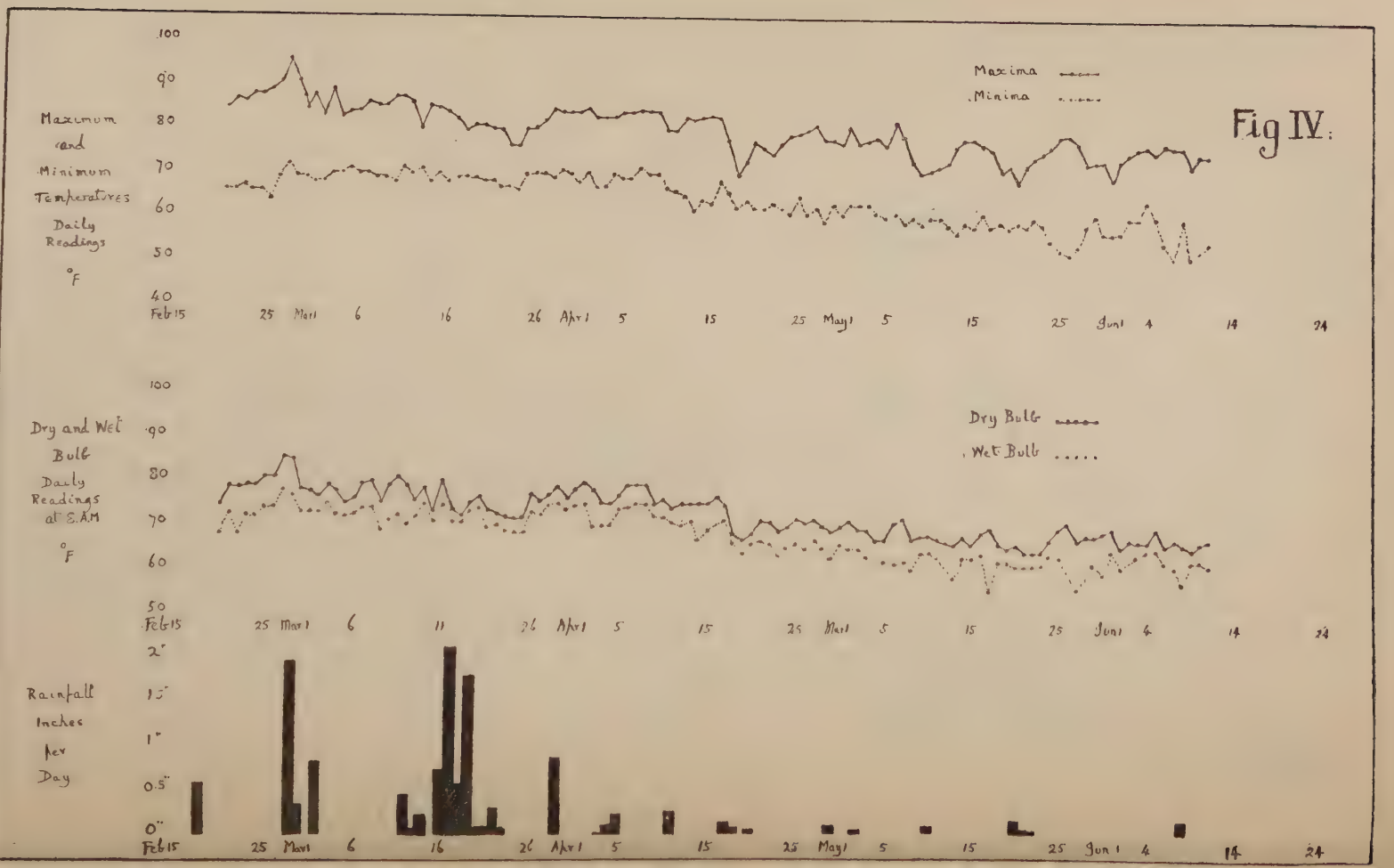

Maximum and Minimum Temperatures Daily Readings °F
100
90
80
70
60
50
40
Maxima
Minima
Feb 15
25
Mar 1
6
16
26
Apr 1
5
15
25
May 1
5
15
25
Jun 1
4
14
24
Dry and Wet Bulb Daily Readings at 8 A.M °F
Dry Bulb
Wet Bulb
Rainfall Inches per Day
2"
1.5"
1"
0.5"
0"

Fig IV.

pointed out in the last report, it is quite as closely associated with the rainfall distribution. At all events, there would seem to be no particular difference between the temperature-moisture relationships of the two strains.

Bollworm Infestation.—This season, in connection with the genera policy of regarding the insects in the nature of indicators, all attempts at the direct control of bollworms have been dropped. No moth catching has therefore been done. The collection and analysis made from the bulk neighbouring the variety trial could not, of course, have had any material effect in controlling the pests since the numbers dealt with were so small.

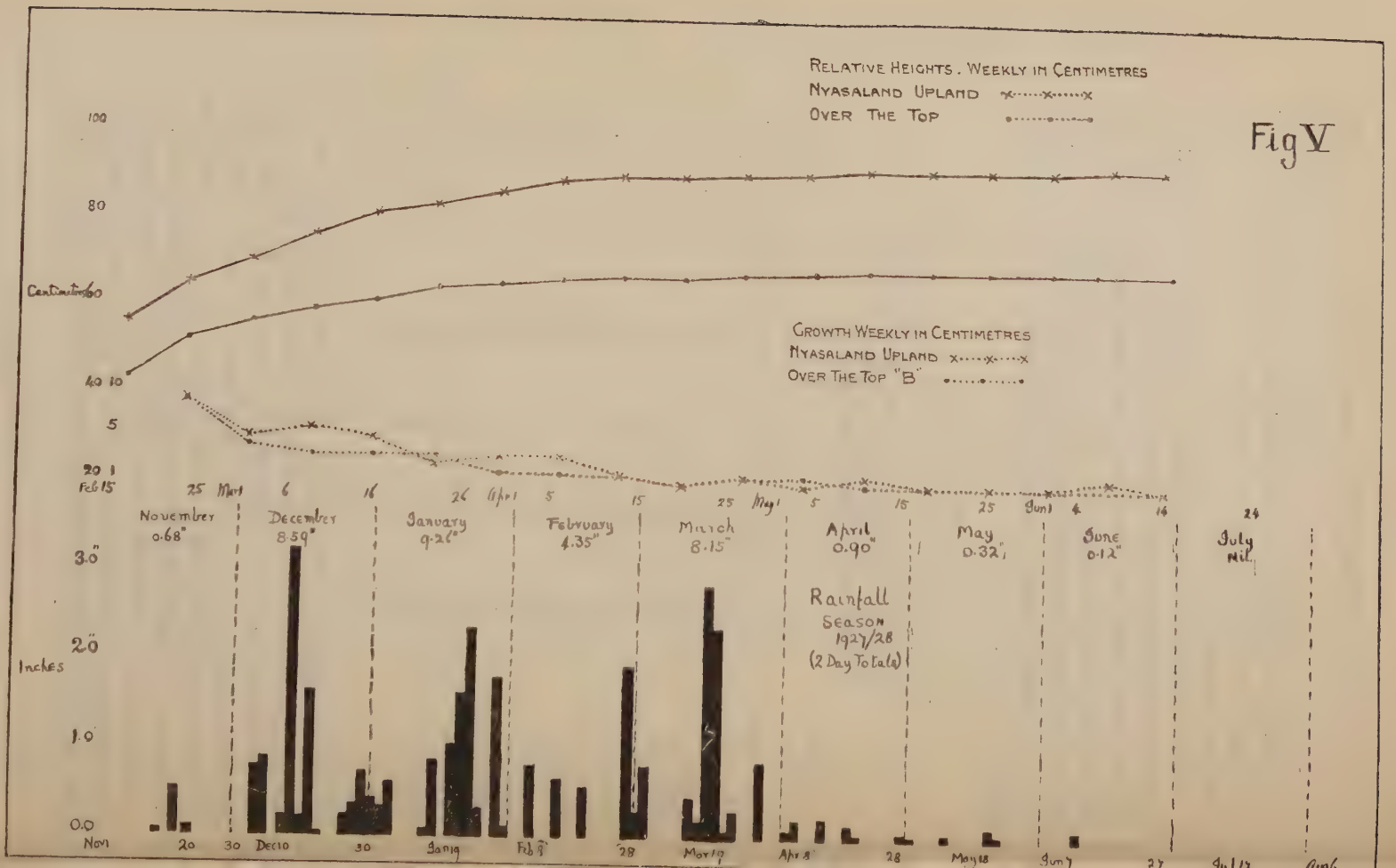
TABLE III.

ANALYSIS OF BOLLWORM POPULATION: WEEKLY COLLECTIONS.

Red Bollworm (*Diparopsis castanea*)=R.B.W.
American Bollworm (*Chloridea obsoleta*)=A.B.W.
Spiny Bollworm (*Earias* sp.)=S.B.W.

Date.	*R.B.W.*	*A.B.W.*	*S.B.W.*	*R.B.W.*	*A.B.W.*	*S.B.W.*
				Per cent.	Per cent.	Per cent.
February 25, 1928	103	3	3	94	3	3
March 3 ..	92	2	1	97	2	1
March 10 ..	91	28	5	73	23	4
March 17 ..	38	62	2	37	61	2
March 24 ..	44	61	3	41	56	3
March 31 ..	67	32	3	66	31	3
April 7 ..	96	13	1	87	12	1
April 14 ..	100	1	2	97	1	2
April 21 ..	90	2	2	96	2	2
April 28 ..	90	1	4	95	1	4
May 5 ..	85	4	1	95	4	1
May 12 ..	74	—	2	97	—	3
May 19 ..	77	—	6	93	—	7
May 26 ..	85	—	5	94	—	6
June 2 ..	82	—	2	97	—	3
June 9 ..	72	—	1	99	—	1
June 16 ..	26	—	5	84	—	16

The above table is very like that of last season's report except for the marked infestation of American Bollworm during March. This infestation may have two explanations: There may have been (1) a special invasion of this species this season; (2) faulty observation last season, which has been remedied this season. It was found that a number of American larvæ were missed owing to the method of collection whereby natives collected bolls and other infested material and sorted out the worms afterwards in the laboratory. It was found that the habit of the American Bollworm of strolling about the plant


Relative Heights. Weekly in Centimetres
Nyasaland Upland
Over the Top
Fig V
Growth Weekly in Centimetres
Nyasaland Upland
Over the Top "B"
Centimetres
Inches
November 0.68"
December 8.59"
January 9.26"
February 4.35"
March 8.15"
April 0.90"
May 0.32"
June 0.12"
July Nil
Rainfall Season 1927/28 (2 Day Totals)

made the collectors miss many by this method. This season, therefore, all the caterpillars on a group of plants were collected.

If it be confirmed next season, it would appear that the Red Bollworm has in a large measure been given an undue importance at Makwapala, and that a very serious loss, occurring in mid-March, is due to *Chloridea*. The marked peak in the two bollworm loss curves (Figs. 2 and 3) would certainly seem to indicate that this is so.

COTTON-BREEDING WORK.

Farm Bulk Sowings.—Over-the-Top B (mixed bulk) was again used as the main cotton on the Farm. The average yield obtained this year was not, however, as good as last season, just under 200 lbs. per acre seed cotton as compared with 360 lbs. last season.

This was due to a variety of causes, of which probably the most important was its breakdown in jassid-resistance, coupled with the very severe stainer infestation referred to above.

The extra amount of jassid attack this season is probably due to climatic conditions rather than to any abrupt change in the constitution of this strain, and is quite possibly connected with soil conditions. There are two factors of considerable importance affecting the Makwapala soil: one, the laterisation of the subsoil, which appears to have occurred in considerable measure since the Station was cleared; the other, the loss of surface soil due to soil erosion. Both have had an opportunity this season of showing their effects amplified by other factors working against the crop, in particular indifferent cultivation. It is to be hoped, however, that the ridge terracing, now completed, and improved implements and cultivation, may nullify these effects in the future. Elsewhere than on the Station the bulk strain B has been a decided success this past season, in at least two instances beating last year's record yields. In fairness to the Station, however, it must be pointed out that in the general way the test distribution plots were sown on picked soil.

Increase Bulks of Selected Strains of Over-the-Top.—As indicated in last year's report, a number of the most promising rows were this season bulked with a view to replacing the parent stock. These increase plots were sown in Field 1, where they found, perhaps, rather better soil conditions than those experienced by the ordinary bulk. In spite of this, however, they were severely tested, and what might have been an embarrassingly numerous collection of substrains has been reduced to reasonable numbers by the outstanding superiority of one line, the B-30 selection made by Mr. Sampson in 1925.

Of this selection three substrains were grown, B-30-1, B-30-6, and

B-30-13. All three proved to be outstandingly resistant to jassid, and all cropped well in comparison with the rest of the Over-the-Top on the Farm under the severe pest conditions experienced this season; their average yield being 400 lbs. seed cotton per acre, over double that of the bulk, and equal to that of the test distribution plots sown elsewhere. Two (B-30-1 and B-30-13) have been selected for further bulking, and more detailed examination and comparison this coming season with a view to replacing the present bulk with one or the other.

Progeny Rows.—These were sown in Field 9, south side, from the seed stocks obtained from last year's progeny rows. In addition, observation plots of U 4 and A 12 supplied by Mr. Parnell of Barberton were grown. The balance of the field was sown with bulk Foster-Whitehall H-2-3 and H-1-5, a small bulk of ordinary Over-the-Top Strain B, and an observation plot of Improved Bancroft kindly supplied by the Rustenburg Experiment Station. The work was simplified by the failure of everything except the Over-the-Top and the Barberton strains to resist the jassid, and the net result of the season's work has been a wholesale scrapping of strains.

The only cotton retained for sowing this coming season are Over-the-Top (bulk and re-selections), Barberton U 4, and Barberton A 12.

In addition to these will be sown a number of newly-imported strains of jassid-resistant cottons, in particular U 4 and Cambodia strains from the Corporation's Gatooma Station, South Rhodesia.

As a jassid control, Foster-Whitehall G from Port Herald will be sown in strips between the various strains of cotton to be tested. Makwapala is indebted to Barberton for this idea. Strain G, as before reported, season 1925-26, is very susceptible to jassid under the Makwapala conditions.

It is not proposed to give in this report the results obtained this season from the Barberton strains, since the small plots grown do not justify any conclusions as to yielding possibilities. Neither cropped particularly well, but individual plants in each showed considerable promise. Lint characters appear to be quite up to South African standards.

A further attempt this next season is to be made to try and discover a longer linted strain in the Over-the-Top B. So far our best efforts have failed to reveal anything longer than 25 mm. combed length—*i.e.*, $1\frac{1}{8}$ inches commercial Liverpool length. For this reason reserve seed from the record 1927 crop in Field 10 is to be used in preference to seed from this year's crop, for the bulk sowings. It is thought that this is likely to yield fewer rogue plants of doubtful

origin, and so increase the chance of any long-linted selection breeding pure.

The following gives the general characters of the Over-the-Top bulk in comparison with the two substrains mentioned above:

TABLE IV.

	Lint Length (Mms., Combed).	*Ginning (Per Cent.).*	*Lint Index.*	*Weight of 100 Seeds (Grms.).*
Over-the-Top B. (Makwapala)	21·5±0·12	31·5	4·8	10·2
Over-the-Top B. (Namalanga Estate)	22·3±0·15	33·2	—	—
Over-the-Top B-30-1 ..	24·4±0·118	31·9	4·7	9·9
Over-the-Top B-30-13 ..	23·5±0·15	31·6	4·5	—

The Makwapala Over-the-Top and the two substrains may be compared to show the improvement made in the lint length. The Namalanga Estate lint length is given to show what the bulk will do under good conditions. The plot at this estate was a particularly good one, giving 581 lbs. seed cotton per acre off a quite poor stand. This estate is at the same elevation as Makwapala, but about forty miles south at the other end of the Palombe plain. The high ginning percentage at Namalanga must be discounted by the higher proportion of unfilled seed in the sample: the Makwapala cotton was much more rigorously graded before ginning.

INSECT PESTS.

In addition to the work described above under "Continuous Records," several studies were made of the insect pests.

Stainers.—An attempt was made to trace by means of a series of cotton-seed traps surrounding the Station field the source and incidence of the stainer invasion of the Station. The traps were examined bi-weekly and the number of stainers noted. The species concerned were *Dysdercus* sp.

It was discovered that the general direction from which the stainers were coming was south-east, the direction from which the prevailing wet season winds come to Makwapala. The stainers were first seen about mid-February, and were numerous by March 4. Nymphs were first found on March 8, and with the wet drizzly weather which set in about mid-March the infestation of the Station was soon heavy and complete.

No host plants were discoverable near Makwapala, from which it seemed possible that the invasion could have emanated, and it

seems probable that the stainer came from a distance. It is known that *Baobab* and *Sterculia* sp. occur in the centre of the Palombe plain and on Lake Shirwa Island, and it seems possible that the seasonal invasion may start from these host trees. The areas in which the *Baobab* and *Sterculia* occur are lower and more humid than Makwapala, and would make admirable over-wintering sites for the stainer.

The experience gained with the traps lends weight to the view that they would not commend themselves to the native cotton-grower. Whether they prove of value as a control of stainers on estate cotton is a matter for experiment, but the writer's inclinations are at present in favour of stainer control by evasion of the pests by means of early cotton and/or plant-breeding measures.

Jassid.—At the request of Mr. Parnell, a study was made of Over-the-Top, Foster-Whitehall H, and the U 4 and A 12 strains supplied by him, in their relationships to this pest. This gave figures comparable with the Barberton results, as the following table shows:

TABLE V.

JASSID NYMPHS PER THREE LEAVES OF TWENTY PLANTS EACH.

Date.	*Over-the-Top.*		*Foster-Whitehall.*		*Ba-U4.*	*Ba-A12.*
	A.	*B.*	*H*-1-5.	*H*-1-7.		
March 5	21	13	26	195	67	21
„ 12	21	32	29	202	83	24
„ 19	29	31	35	137	62	22
„ 26	34	69	105	243	198	99
April 2	49	50	134	220	239	105
„ 9	36	38	115	174	173	130
„ 16	46	47	99	129	148	120
„ 23	45	55	68	103	59	134
„ 30	22	19	63	81	33	53
May 7	12	6	35	32	17	21
„ 14	4	3	22	26	9	13

The last count of jassid was made on May 14, by which time most of the H-1-7 were leafless, H-1-5 much like U 4, but probably rather more damaged, the Andrews 12 and the Over-the-Top much the same.

It was noted that in addition to jassid attack *Aphis* and *Psylla* sp. were responsible for a certain amount of damage, and it seems possible that the latter may be more important than has been thought up to the present.

It was, however, clearly shown that varietal differences are much

the same at Makwapala as at Barberton, and that similar remedies are likely to prove efficacious in combating the jassid.

Hair counts were made, and the following figures give the density per square millimetre:

Over-the-Top.		*Foster-Whitehall.*		*U*4.	*A*12.
A.	*B.*	*H*1-5.	*H*1-7.		
7·2	7·5	3·6	2·1	5·5	6·5

Nyasaland Upland from Field 7 examined for comparison gave the intermediate figure 5·8.

PORT HERALD COTTON STATION, REPORT FOR THE SEASON 1926-27

BY

J. V. LOCHRIE.

Introduction.—The general layout of the Station was described in the Report for season 1926–27, the only change made being that a beginning was made with the clearing of a small additional acreage near to the labour quarters. A part of this was planted in Napier Fodder Grass to afford grazing for the cattle during the season. Any introductions of potential rotation crops will in future be grown in this block, and the twelve fields of the Station used only for the cottons and the bulk rotation crops. The rotation scheme of the previous season was carried on into the second year, but, in view of the need for more acreage for observation bulks, it has been decided to modify the scheme to some extent. Half the acreage—*i.e.*, six fields—will be devoted to cotton and, of the others, three will be planted with the main cereals and three with leguminous crops, giving a four-year rotation, with cotton occurring twice, once after a cereal and once after a pulse crop.

The planting of trees was continued along the Station boundaries and around the buildings, and Napier Fodder Grass planted round the field borders. A large main drain was dug along the central road of the Station, and this has been successful in stopping all wash on the area.

A large number of single-plant selections of cotton were grown and various observation bulks, including several promising importations. Jassid attack on the station was severe. This attack, which is dealt with in another section of the Report, was intensified by the presence of early-planted cotton in the Time-of-Planting experiment, which provided an early breeding-ground for the pest. Bollworm and stainer were again responsible for much damage.

Season.—The season was fairly satisfactory as far as the cotton crop was concerned.

The rainfall was very low, and the hot dry spells immediately following the plantings on February 17, and later in April, tended to depress yields. From the rainfall chart it is seen that the total

rainfall was very little less than in the previous season, and the distribution somewhat similar.

With the rotation crops the position was very different—the long hot and dry spell from the middle of January onwards had a very serious effect on the food crops of the whole district. Except in the case of groundnuts and bush Lima beans the yields were low, the cereals in particular being very poor.

The rains broke early in November, and light showers were experienced during that month, followed by heavy rains in December and the first half of January. A three weeks' spell of very dry weather followed and sowing of cotton began with the next fall. The spacing experiments were planted on February 11 and a good fall on the 17th gave these a good start. The progeny rows, small bulks and variety trials planted on the rains of February 18, were subjected to ten days' very dry weather and many of the young seedlings died off. Rain fell again at the end of February and continued with more or less regular showers till the end of April.

Picking commenced in July, and no rains were experienced to interfere with this work. The insect pests will be referred to later in the Report; jassid, bollworm, and stainer all occurred in considerable numbers.

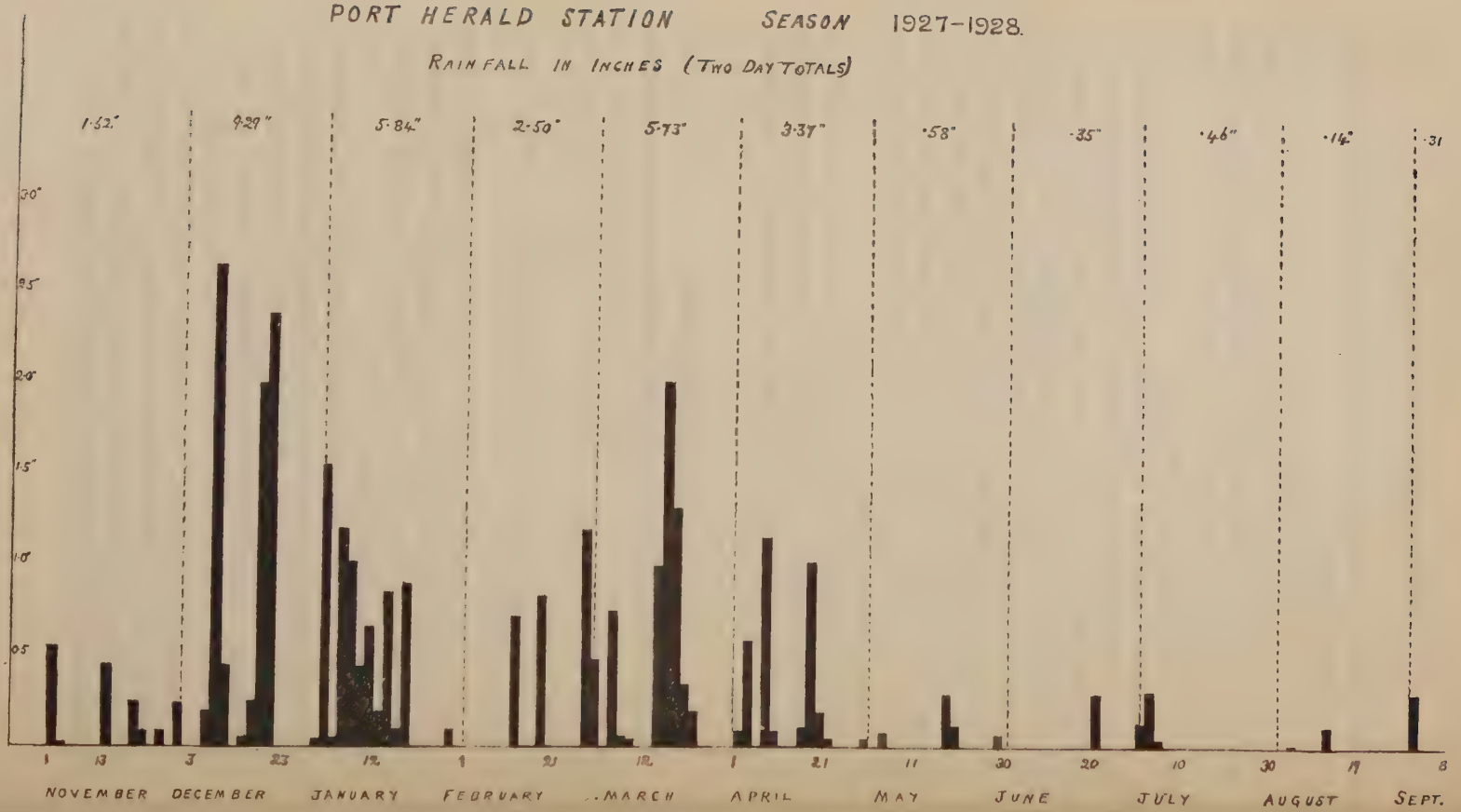
Field Experiments.

A series of spacing experiments, variety trials, and time-of-planting experiments were laid out, employing in all cases the half-drill strip layout as in the previous year, but the number of replicates was increased to eight.

The size of plot used was $\frac{1}{40}$ acre, made up of 5 rows (4 feet apart) of 54 feet in length.

Spacing Experiment.—Strain "G" was sown in continuous lines 4 feet apart and later thinned out to the required spacings. Germination was good and a very fine stand obtained. The standard spacing used was one plant at 2 feet in the rows.

In no case was there any significant difference between the spacings, though the standard employed (4 by 2 feet [1 plant]) was slightly less in yield in each case. It would appear that a somewhat more dense spacing would be of advantage. Though the results are inconclusive they are substantially the same as in the previous year. In both seasons the yield of the standard spacing of 4 by 2 feet (1 plant) was less than that of any of the spacings on trial, and, further, the two highest increases from standard were those at 4 by 2 feet (2 plants) and 4 feet by 6 inches (1 plant) in both seasons.


PORT HERALD STATION SEASON 1927-1928.
RAIN FALL IN INCHES (TWO DAY TOTALS)
1·52"
9·29"
5·84"
2·50"
5·73"
3·37"
·58"
·35"
·46"
·14"
·31
3·0"
2·5"
2·0"
1·5"
1·0"
·5
1 13 3 23 12 1 21 12 1 21 11 30 20 10 30 19 8
NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPT.

PORT HERALD STATION.

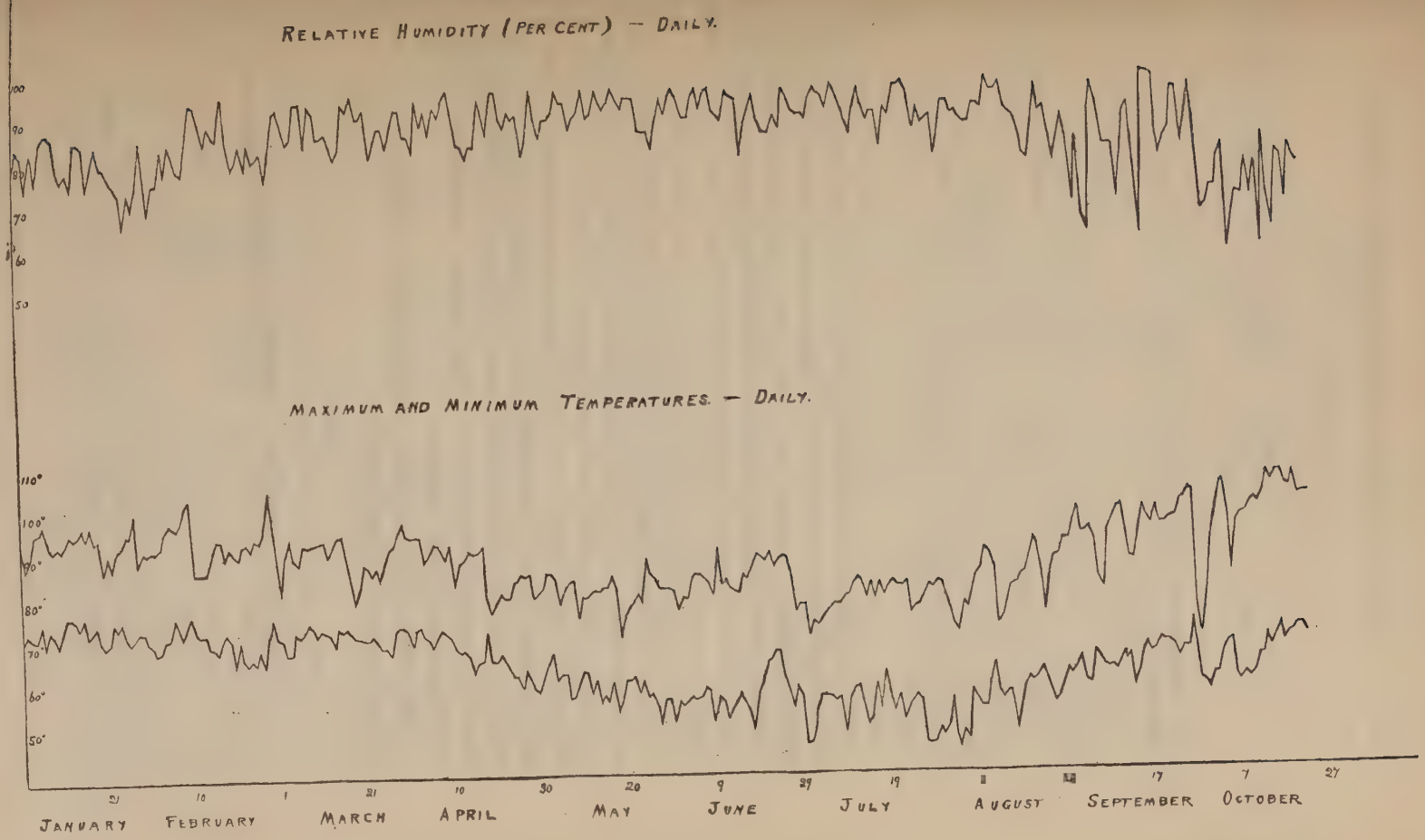


TABLE 1.

Spacing.	*Mean Plot Yield (lbs.)*	*Equivalent per Acre. (lbs.)*	*Mean Difference of Plot Yields.*	*Standard Error.*
4 by 2 ft. (2 plants) ..	11·7	415	+1·02	0·468
Standard	10·7	456		
4 by 1½ ft. (2 plants) ..	11·3	447	+1·76	1·175
Standard	9·7	378		
4 by 1½ ft. (1 plant) ..	11·2	445	+0·63	0·383
Standard	10·9	423		
4 by 1 ft. (1 plant) ..	12·1	483	+0·54	0·90
Standard	11·8	460		
4 ft. by 6 ins. (1 plant) ..	12·1	484	+1·89	0·88
Standard	10·7	418		

This experiment will be carried into the third year, with the only difference that a spacing closely approximating to native practice will be included—*i.e.*, 4 by 2 feet (*circa* 4 plants). During the present season a spacing like this was laid down, but owing to much seed destruction by a millipede it proved useless.

Variety Trials.

Two series were laid down, using the half drill strip layout and eight replicates per variety and a standard spacing of 4 by 2 feet (1 plant). The varieties used were Strain "G," Strain "B," and a Nyasaland Upland strain, "V," which was used as standard. Planting was carried out on February 18, and was followed by a dry spell which to some extent lowered the stands obtained. This was aggravated by damage by white ants which occurred whenever rain fell following a spell of dry weather.

The results obtained show a significant yield difference in favour of the Nyasaland Upland strain.

TABLE 2.

Strain.	*Plot Yield (lbs.)*	*Equivalent per Acre.*	*Mean Plot Difference (lbs.)*	*Standard Error.*	*Significance.*
V ..	16·54	661·5	3·42	0·93	3·7
B ..	13·12	524·0			
V ..	15·93	637·5	4·08	1·16	3·5
G ..	11·85	473·0			

Plant Development Records.

The following records were kept on the middle row of each plot, 20 plants from each plot, making a total of 160 plants per variety.

(*a*) Flowers opening daily.

(*b*) Bolls bursting weekly.

(*c*) Bollworm infestation; all bollworm infested material was removed daily and analyzed into (1) buds attacked and (2) flowers and bolls attacked.

(*d*) Weekly measurements of growth. Owing to the very considerable topping by bollworm and by stem-girdling these figures were valueless except as an indicator of the cessation of growth.

(*e*) Weekly collections and analyses of bollworm population.

(*f*) Weekly collections and analyses of shed material.

Flowering Curves (Fig. 1).—The flowering of the three strains was substantially the same, and in no way accounts for the difference in final yield.

Bolling Curves (Fig. 2).—The yield superiority of the V strain as shown by the yield figures and by the bolling curves cannot be explained entirely on the general bollworm infestation either of buds (Fig. 3) or of flowers and bolls (Fig. 4). On the whole, it will be noticed that Strain V suffered less from bollworm loss in the flowers and bolling stage than the others, and this combined with a lesser attack of stainer-carried bollrots accounts for the difference in yield.

The yield of the three strains is analyzed in Table 3.

TABLE 3.

Strain.	*Number of Flowers per Plant.*	*Loss by Bollworm.*	*Number of Bolls Picked.*	*Mean Boll Weight (grms.).*	*Loss by Other Causes.*
V ..	52·5	17·3	21·2	5·10	13·9
B ..	53·5	18·4	18·5	5·20	16·6
G ..	51·5	18·7	16·7	5·15	16·1

Strain.	*Bolls Picked (Percentage of Flowers).*	*Bollworm Infestation (per Cent.).*	*Loss by Other Causes (per Cent.).*
V ..	40·6	32·8	26·6
B ..	34·7	34·7	30·6
G ..	32·5	34·4	33·1

The actual production of flowers per plant shows great similarity in the three varieties, and the difference in final yield, the boll weight

PORT HERALD.

FIG. I.

FLOWERING CURVES. PER PLANT PER DAY. — 5 DAY MEANS.

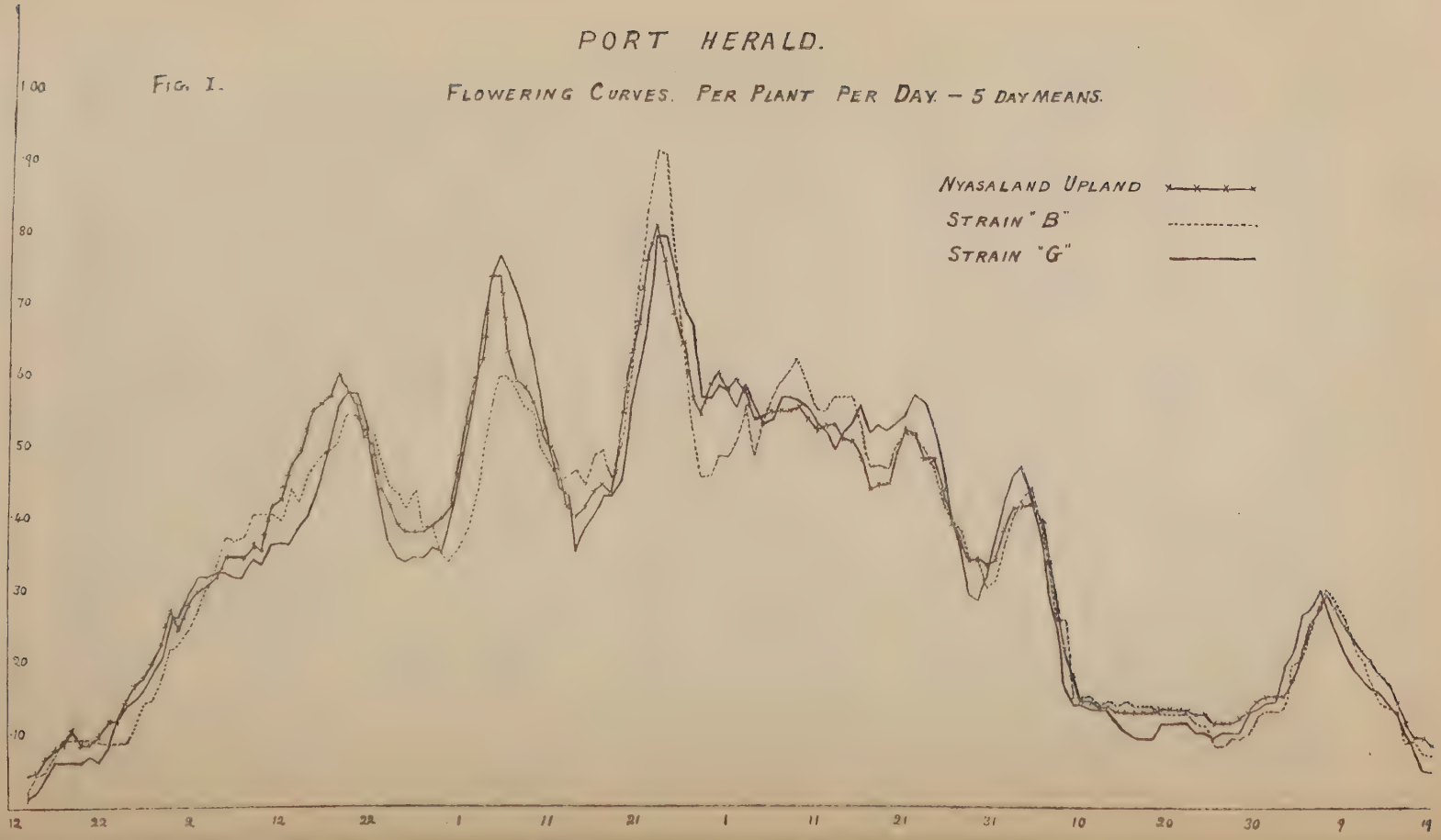
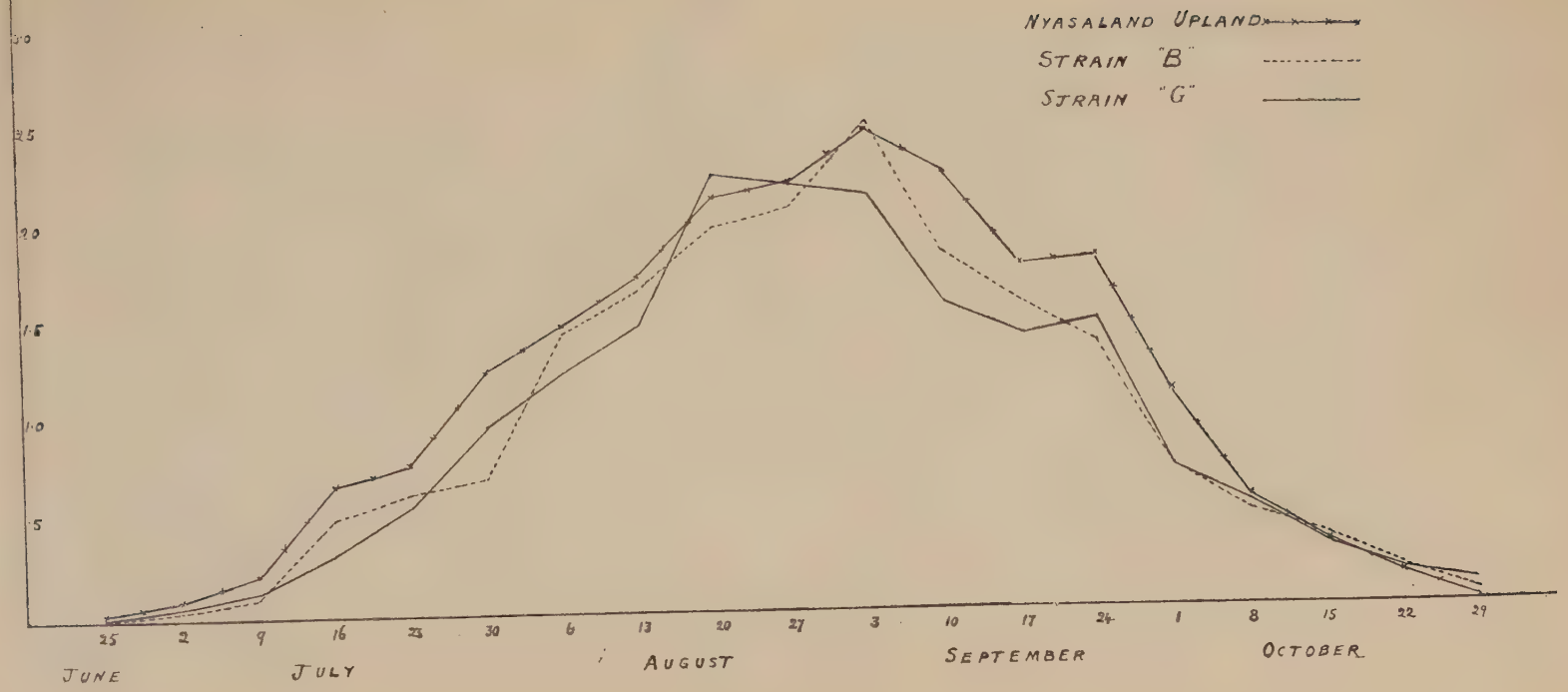


FIGURE 2. BOLLING CURVES PER PLANT — WEEKLY TOTALS.



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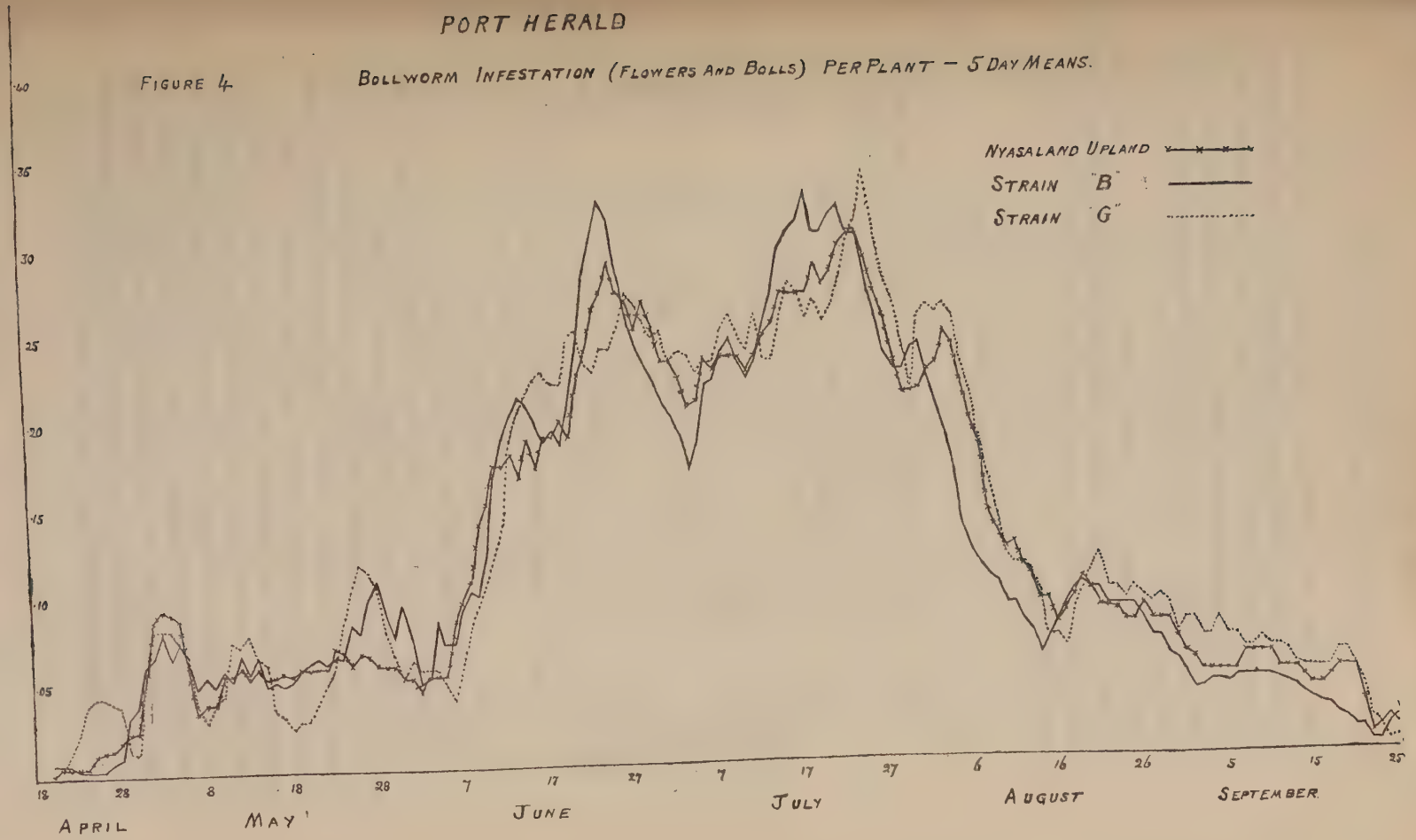
BOLLWORM INFESTATION (BUDS ONLY) PER PLANT - 5 DAY MEANS

FIGURE 3.

PORT HERALD

FIGURE 4 BOLLWORM INFESTATION (FLOWERS AND BOLLS) PER PLANT — 5 DAY MEANS.



being comparable, is due to the considerably smaller loss sustained by Strain V from bollworm and other causes. The loss by bollworm is similar in the case of Strains B and G and considerably less in Strain V. The loss by other causes is obtained by subtraction, and it is apparent that this factor has been the more important in deciding yield superiority.

Table 4 gives an analysis of sheddings collected from a neighbouring bulk. No natural shedding apart from buds was observed, and consequently the non-bollworm loss can be attributed to insect-carried bollrots.

TABLE 4.

Analysis of Shed Material—Weekly Collections.

Date.	A. Showing Bollworm Attack.			B. Not showing Bollworm Attack.		
	Buds.	Flowers and Bolls.	Total.	Buds.	Flowers and Bolls.	Total.
16/5/28 ..	233	61	294	—	12	12
23/5/ ..	412	103	515	—	52	52
30/5/ ..	350	98	448	14	96	110
6/6/ ..	386	172	558	13	71	84
13/6/ ..	121	212	333	12	107	119
20/6/ ..	85	157	242	18	190	208
27/6/ ..	27	143	170	15	177	192
5/7/ ..	34	166	200	21	177	198
12/7/ ..	7	91	98	3	161	164
19/7/ ..	66	82	148	72	83	155

Note.—No natural shedding of flowers and bolls was observed.

Cotton-breeding Work.

Single plant selections of Strains "A" and "B" of Over-the-Top; strains "G" and "H" of Foster Whitehall; Arizona (N) and Z.1 were carried on from the previous season 1926-27.

Table 5 (p. 237) summarizes the lint and seed characters of the selections. In addition, several importations of various strains were added to provide a wider range for selection. A range of Cambodia types was obtained from Gatooma, these consisting of five single-plant selections and three small bulk lots. The other importations were made up of a U.4 bulk (U.4/5 and An-12/2) and two small bulks of Durango. Three Webber strains which had previously been grown at Makwapala were also included. These had proved jassid-susceptible, and it was considered that the addition of susceptible types like these and the Durangos, together with the

TABLE 5.

Single Plant Selections Sown in Season 1927-28.

Plant Serial Number.	*Lint Length (mms.).*	*Ginning (per Cent.).*	*Weight of 100 Seeds (grms.).*	*Lint Index.*
A-2-32-1 ..	25·75	33·2	11·5	5·7
A-2-32-2 ..	27·25	35·7	10·2	5·6
B-30-11-1 ..	26·75	34·5	8·3	4·2
B-30-11-2 ..	28·65	34·6	8·5	4·5
B-30-11-3 ..	28·65	37·6	8·4	5·1
B-30-11-4 ..	27·90	37·1	9·4	5·5
B-42-2-1 ..	28·00	37·8	9·4	5·7
B-42-2-2 ..	29·20	37·4	9·3	5·6
B-42-2-3 ..	29·25	37·2	9·4	5·6
B-42-8-1 ..	27·20	33·8	9·0	4·6
B-42-12-1 ..	27·75	30·1	9·6	4·1
B-42-12-2 ..	26·35	34·8	9·3	5·0
B-46-20-1 ..	28·20	35·5	10·6	5·8
B-46-20-2 ..	27·90	31·2	9·7	4·4
H-1-6-1 ..	30·50	38·2	9·5	5·9
H-1-6-2 ..	30·90	36·8	11·2	6·5
H-1-6-3 ..	30·00	31·0	10·5	4·7
H-1-6-4 ..	29·30	37·8	9·5	5·8
H-1-6-5 ..	31·20	37·8	9·0	5·5
H-1-6-6 ..	30·85	36·8	8·9	5·2
H-1-6-7 ..	30·95	34·2	10·5	5·3
H-1-6-8 ..	29·45	37·6	9·0	5·4
G-15-8-1 ..	29·75	35·4	9·8	5·4
G-15-8-2 ..	30·60	34·8	9·3	5·0
G-15-8-3 ..	29·95	36·6	9·7	5·6
G-15-8-4 ..	30·55	34·7	8·9	4·7
G-6-4-1 ..	32·45	33·2	8·3	4·1
G-6-4-2 ..	31·40	36·2	8·9	5·0
G-6-4-3 ..	30·00	36·8	8·5	5·0
G-6-4-4 ..	32·15	36·4	8·8	5·0
G-2-17-1 ..	29·75	36·0	10·0	5·6
G-2-17-2 ..	30·25	35·4	10·4	5·7
G-2-17-3 ..	31·50	37·7	9·6	5·8
26G-35-1 ..	30·45	36·3	9·8	5·6
26G-35-2 ..	30·20	35·8	9·1	5·1
26G-35-3 ..	32·55	36·3	9·1	5·1
26G-35-4 ..	30·80	35·2	10·0	5·4
26G-35-5 ..	30·00	36·3	9·8	5·6
26G-35-6 ..	32·45	36·6	10·3	5·9

resistant Cambodias, would present an adequate range for a study of the jassid problem.

With the exception of the Webber strains, all the selections and observation plots were planted on February 18. Stands were affected by millipede damage during the dry spell immediately following the planting, but a sufficient number survived.

It was early apparent that the plant type of the Cambodias even

in this, a very dry, season was too vigorous in growth. Their denseness combined with lateness and lax habit provided an efficient harbourage for families of stainer. They proved very resistant to jassid, and several of the more open and less lax plants have been selected for planting next season. On account of their resistance to jassid, high productivity and big, easily picked bolls, these Cambodias are a promising addition to the station seed-stocks. One or two early and erect plants were observed which showed decided Egyptian characters and appear to be hybrids of mixed Egyptian origin. One of these gave the high yield of 23½ ounces of seed cotton, the number of bolls picked being just over two hundred. The ginning percentage and lint length of the Cambodia strains were very good.

Foster Whitehall (Strain G) was, to a large degree, a failure on account of jassid attack. A few of the selections showed some degree of resistance, but not sufficient to warrant carrying them on. Re-selections were made, from the bulk of Strain " G," of some plants which showed a marked superiority in their resistance to jassid, and these will be planted next season for further observation. Strain H proved fairly resistant both in its single plant selections and in observation plots.

Over-the-Top (Strains A and B) showed little evidence of jassid attack, but were disappointing in yield. The actual boll production was good, but much loss by bollrot occurred. The plant type is a short, very dense bush under which the late July and August migrations of stainer found welcome shade.

Arizona (N) showed fair jassid-resistance and several promising selections were made, but the Z.1 afforded little material for selection.

The two importations of U.4/5 and An-12/2 gave some promising selections as regards resistance to jassid, the An-12/2 lot being highly resistant. Both types were very early, yielding well, with the U.4/5, on the whole, superior.

Durango was early attacked by jassid and gave little crop.

Selections were made from various localities from the local Nyasaland Upland, the selection in the field being based on resistance to jassid and good plant type. Many of these were discarded later on account of low ginning percentage and low lint lengths, and the rest will be grown on the station next season.

In all about eighty progeny rows were grown this season, a large number being rejected on the ground of jassid-susceptibility.

Tables 6 and 7 (pp. 239-241) show the lint and seed characters of the selections it is proposed to plant in the coming season. These should provide a wide range of types for selection.

TABLE 6.

Characteristics of Selections for 1928-29.

Plant Serial Number.	*Mean Maximum Lint Length (mms.).*	*Ginning (per Cent.).*	*Weight of 100 Seeds (grms.).*	*Lint Index.*	*Mean Boll Weight (grms.).*
A2/1 ..	27·3	33·5	9·4	4·7	5·10
A2/2 ..	27·9	30·6	10·9	4·8	5·06
B-30/1 ..	27·1	33·2	9·0	4·5	6·25
B-30/2 ..	26·6	31·7	9·3	4·3	6·85
B-30/3 ..	26·4	32·8	9·7	4·7	6·30
B-30/4 ..	25·4	33·2	9·4	4·7	6·10
B-42/1 ..	28·0	32·2	10·8	5·1	4·80
B-42/2 ..	27·3	32·5	10·9	4·9	5·40
B-42/3 ..	25·3	30·8	10·6	4·7	6·60
B-46/1 ..	27·0	35·2	11·8	6·4	7·89
B-46/2 ..	28·8	29·7	11·9	5·0	7·43
B-46/3 ..	29·0	28·8	13·9	5·6	6·15
H-1/1 ..	29·5	33·1	10·1	5·1	5·30
H-1/2 ..	30·0	31·3	10·3	4·7	5·60
H-1/3 ..	27·0	34·6	9·9	5·2	5·30
H-1/4 ..	27·4	37·5	10·4	6·3	6·10
H-1/5 ..	27·9	33·7	9·6	4·9	5·81
H-1/6 ..	29·1	36·5	10·4	6·0	6·10
H-1/7 ..	28·4	38·5	10·5	6·6	6·00
Z1/1 ..	29·4	30·8	12·8	5·7	6·94
Z1/2 ..	29·4	27·9	12·4	4·8	6·73
N5/1 ..	28·7	29·2	12·3	5·0	4·50
N8/1 ..	30·0	28·6	12·1	4·8	4·40
N10/1 ..	30·6	31·7	11·6	5·4	6·52
N17/1 ..	32·6	33·8	11·8	6·0	5·63
N21/1 ..	29·1	29·2	11·6	4·8	5·60
N21/2 ..	31·0	27·8	13·1	5·1	6·21
Re-Selections from bulk of Strain "G."					
G1 ..	29·2	37·2	6·2	3·7	
G2 ..	27·1	35·3	8·2	4·5	
G3 ..	30·8	35·6	6·8	3·7	
G4 ..	32·4	36·7	7·4	4·4	
G5 ..	28·3	35·3	8·6	4·7	
G6 ..	29·9	37·8	8·3	5·0	
Nyasaland Upland Selections.					
NU/1 ..	28·4	34·0	10·8	5·6	5·80
NU/2 ..	26·6	34·7	9·0	4·7	4·90
NU/3 ..	28·4	31·7	10·3	4·8	5·30
NU/4 ..	28·8	30·9	9·6	4·3	5·80
NU/5 ..	26·0	33·6	10·9	5·5	4·60
NU/6 ..	27·4	37·2	9·8	5·8	5·20
NU/7 ..	27·6	34·0	9·9	5·1	5·21
NU/8 ..	33·3	30·6	11·8	5·2	4·70
NU/9 ..	27·9	34·2	9·5	4·9	5·98
NU/10 ..	28·0	32·9	10·0	4·9	—
NU/11 ..	32·4	35·2	9·2	5·0	—

TABLE 6 (*Continued*).

Plant Serial Number.	*Lint Length (mms.).*	*Ginning (per Cent.).*	*Weight of 100 Seeds (grms.).*	*Lint Index.*
N-5	29·70	34·3	9·3	4·9
N-8	29·00	34·3	9·5	5·0
N-10	30·70	35·7	9·5	5·3
N-17	31·40	34·2	10·9	5·7
N-19	30·30	31·5	11·8	5·4
N-21	29·40	34·3	10·2	5·3
N-25	30·80	35·0	10·3	5·5
Z1-1	31·30	31·9	10·6	5·0
Z1-2	31·20	33·3	11·8	5·9
Z1-3	32·65	33·2	9·0	4·5
Z1-4	29·65	33·3	9·9	5·0
Z1-5	32·60	31·6	11·1	5·1
Z1-6	31·05	30·8	12·1	5·4
Z1-7	29·70	34·2	10·1	5·3
Z1-8	30·70	30·4	9·6	4·2
	Importations. Cambodia Selections from Gatooma.			
GC-6-A ..	27·70	36·1	11·7	6·63
GC-10	28·20	36·2	12·94	7·37
GC-7	27·90	37·7	12·61	7·69
GC-4	31·60	35·5	10·54	7·03
GC-15	28·90	38·3	12·62	7·86

TABLE 6 (*Continued*).

Observation Plots.

Serial Number.	*Lint Length (mms.).*	*Standard Deviation.*	*Ginning (per Cent.).*	*Weight of 100 Seeds (grms.)*
26G-35 ..	29·44	1·723	37·2	9·5
26G-48 ..	29·47	1·439	36·6	9·2
G-1-7	29·12	1·425	36·3	9·3
G-15-8 ..	29·59	1·675	35·9	9·9
H-2-2	28·94	1·390	37·9	10·0
H-3-2	28·32	1·536	37·3	10·4
H-3-8	27·57	1·006	37·6	9·9

Observation Plots.

Seven of the more promising and uniform progeny rows of Strain G and H of last season were planted out as small bulks, a plot of the unselected Strain " G " being grown in the same field to give an index of jassid-resistance. Stands were not good owing to the small amounts of seed available and the dry spell immediately following sowing

TABLE 7.

Plant Serial Number.	*Mean Maximum Lint Length (mms.).*	*Ginning (per Cent.).*	*Weight of 100 Seeds (grms.)*	*Lint Index.*	*Boll Weight (grms.).*
BaU4/5-1 ..	32·0	35·2	8·8	4·8	4·0
BaU4/5-2 ..	31·1	33·8	10·3	5·4	5·5
BaU4/5-3 ..	29·8	36·8	8·4	4·9	4·3
BaU4/5-4 ..	30·4	34·5	8·8	4·6	5·1
BaU4/5-5 ..	29·6	35·7	9·9	5·5	4·8
BaU4/5-6 ..	33·3	36·0	11·0	6·2	4·5
BaU4/5-7 ..	29·0	36·2	9·5	5·4	4·7
BaU4/5-8 ..	29·8	35·0	10·2	5·5	4·2
BaU4/5-9 ..	32·0	37·3	9·1	5·4	4·3
BaU4/5-10 ..	31·3	37·5	9·4	5·6	5·6
BaU4/5-11 ..	32·1	36·4	9·2	5·3	4·5
BaU4/5-12 ..	31·3	38·1	9·3	5·7	4·9
BaU4/5-13 ..	35·8	34·8	10·8	5·7	4·1
BaU4/5-14 ..	32·0	35·1	11·0	6·0	4·6
BaU4/5-15 ..	31·1	36·5	8·9	5·1	4·1
BaU4/5-16 ..	30·6	37·3	10·8	6·4	4·9
BaU4/5-17 ..	31·0	36·0	10·6	6·0	5·1
BaU4/5-18 ..	33·5	34·8	10·0	5·3	4·5
BaU4/5-19 ..	32·4	37·0	9·1	5·3	4·3
BaAn-12/2-1	31·8	33·8	10·4	5·5	6·3
BaAn-12/2-2	34·3	34·1	10·4	5·6	4·9
BaAn-12/2-3	30·4	34·3	9·5	5·0	6·6
BaAn-12/2-4	30·2	33·4	10·3	5·2	5·3
BaAn-12/2-5	30·9	33·9	10·0	5·1	5·4
BaAn-12/2-6	31·4	34·4	10·3	5·4	5·3
BaAn-12/2-7	30·9	36·5	10·1	5·9	5·4
BaAn-12/2-8	31·5	34·5	10·4	5·5	6·1
BaAn-12/2-9	29·4	35·2	10·0	5·4	7·2
BaAn-12/2-10	29·9	33·5	10·2	5·1	6·2
BaAn-12/2-11	30·0	34·0	10·2	5·2	5·8
BaAn-12/2-12	28·3	38·8	10·6	6·7	6·5
GC-1	32·3	34·9	13·1	7·0	7·4
GC-2	33·3	34·4	14·3	7·5	6·8
GC-3	27·0	37·3	11·6	6·9	6·6
GC-4	32·3	39·2	13·9	9·0	7·2
GC-5	28·5	37·0	12·4	7·3	7·8
GC-6	29·9	41·4	11·4	8·0	6·0
GC-7	30·4	40·3	11·7	7·9	7·9
GC-8	28·2	34·8	14·6	7·3	7·9
GC-9	28·8	39·6	12·7	8·3	7·7
GC-10 ..	33·9	36·2	13·8	7·8	4·6
GC-11 ..	27·7	35·7	13·2	7·3	7·6
GC-12 ..	31·3	34·8	13·4	7·1	7·6
GC-13 ..	33·6	36·0	13·1	7·4	6·8

BaU4 and BaAn-12 came from Barberton, and the GC strains from Gatooma.

on February 19, when much damage was suffered from the attack of millipede.

The selected bulks of Strain G showed very little higher resistance to jassid than the unselected bulk, and will not be carried on to another season.

Strain H bulks were fairly resistant and the best, H-2/2 and H-3/8, will be tried out as the bulk cotton of the Station the next season.

TABLE 8.

Bulk.	*Plot Acreage.*	*Plot Yield (lbs.).*	*Equivalent Yield per Acre (lbs.).*	*Stand (Per Cent).*	*Lint Length (mms.).*	*Standard Deviation.*	*Ginning (Per Cent.)*	*Seed Weight (grms.).*	*Boll Weight (grms.).*
H-3-2..	0·23	163	710	40	29·5	0·917	33·3	10·3	5·64
H-2-2..	0·17	204	1,224	49	28·6	1·150	35·2	9·7	1·21
H-3-8..	0·20	155	775	43	28·92	1·660	29·8	10·3	6·79
26G-35	0·23	100	435	61	28·5	—	34·3	9·8	—
26G-48	0·29	127	437	71	28·36	—	36·2	10·0	5·10
G-15-8	0·29	135·5	467	54	27·76	—	32·6	10·6	5·71
G-1-7	0·29	102·5	358	67	27·98	—	35·8	9·6	5·57

Small observation plots of Cambodia and of Durango were also grown. The Durango was almost a complete failure owing to the attack of jassid, the majority of the plants being almost entirely defoliated by the end of April.

The three plots of Cambodia all showed great resistance to jassid, but were too vigorous in growth. GC 664 looked best and gave a satisfactory yield of good cotton, and plants of a more suitable plant type may be isolated from it.

Table 9 gives a comparison of the three plots.

TABLE 9.

Name.	*Plot Yield (lbs.).*	*Acreage.*	*Equivalent Yield per Acre (lbs.).*	*Lint Length (mms.).*	*Standard Deviation.*	*Ginning (Per Cent).*	*Seed Weight (grms.).*	*Boll Weight (grms.).*
GC 664	52	0·064	810	29·5	1·78	35·5	10·1	6·07
GCT ..	50	0·064	780	26·3	1·91	38·8	12·3	7·89
GC 440	24	0·064	375	28·1	1·46	35·4	13·6	7·69

Insect Pests.

Bollworm.—The three types of bollworm—Red, American and Spiny—were present right from the commencement of the season. The red bollworm was present in considerable numbers all through the season, but by the end of June the severity of the attack had lessened. The spiny bollworm was also in evidence throughout the season, but the main damage from this pest was in topping the plants. Destruction of bolls by this bollworm is inconsiderable compared with that caused by the red bollworm and, in the earlier part of the season, by the American bollworm. This latter type showed itself to be of very considerable importance in the destruction of the early crop of bolls.

An endeavour was made during the season, by means of field observation and augmented continuous records, to analyze the total loss of potential crop. The following records were kept:

(*a*) Bollworm-attacked buds (daily). These were picked daily from 160 plants each of three varieties (Fig. 3).

(*b*) Bollworm-attacked flowers and bolls (daily), from the above plants.

(*c*) Weekly collections of shed material from between the rows of a neighbouring cotton bulk and analysis into bollworm-infested forms, and those showing no evidence of such attack (Table 4, p. 236).

(*d*) Weekly pickings of bollworm-infested material from a neighbouring bulk and analysis of the bollworms collected into the three types (Table 10, p. 244).

An interesting point arose in connection with the weekly analysis of bollworm population. It had been decided to make the collections from Field 8, which is situated centrally in the Station and, as it happened, not in close proximity to any cereal crop. Here (see Table 10, p. 244) the classification for the first few weeks indicated the presence of red bollworm exclusively, but observations in the field had pointed to a considerable attack of American bollworm, and subsequently separate collections were made from each of three fields of cotton. Two of these—Fields 2 and 12—were on the border of the station adjoining native gardens. Table 10 shows that, in both fields which bordered on Mapira gardens (*Sorghum vulgare*), the heaviest toll was levied by the American bollworm up to the end of May. After that date the numbers of this type fell away, and after the end of June no larvæ could be found.

It can be seen that the American bollworm has been a pest of considerable importance, even though its effect on cotton planted on or after the middle of February is confined to attack on flower

buds and on the first formed bolls. This pest was also to be observed in considerable numbers on Sorghums and to a lesser degree on Cowpeas (*Vigna* sp.). The seasonal incidence of this American bollworm is a strong argument in favour of late February planting in this area. The red bollworm, though present throughout the entire season, occurs more particularly in the early part and presents to some extent the same problem. In dealing with this pest, as late planting as possible consistent with the crop's requirements is to be recommended, and observations on the incidence of the pest indicate that trap cropping by strips of early planted cotton would be of value. With reference to the subject of trap cropping, it will be observed from Table 10 that the infestation by red bollworm was very high in Field 8 even from the earliest part of the season, and it was in this area that the January 1 and 15 plantings had been sown.

TABLE 10.

ANALYSIS OF BOLLWORM POPULATION, WEEKLY COLLECTIONS.

Red Bollworm (*Diparopsis castanea*)=R.B.W.
American Bollworm (*Chloridea obsoleta*)=A.B.W.
Spiny Bollworm (*Earias* sp.)=S.B.W.

Date.	*Field* 8.			*Field* 12.			*Field* 2.		
	R.B.W.	*A.B.W.*	*S.B.W.*	*R.B.W.*	*A.B.W.*	*S.B.W.*	*R.B.W.*	*A.B.W.*	*S.B.W.*
28/3/28 ..	88	—	—	—	No collection		—	—	
4/4/28 ..	97	—	—	—	No collection		—	—	
11/4/28 ..	104	—	—	—	No collection		—	—	
18/4/28 ..	51	—	1	—	No collection		—	—	
25/4/28 ..	55	2	1	—	No collection		—	—	
1/5/28 ..	40	3	—	No collection			6	64	2
9/5/28 ..	83	9	—	5	81	1	7	57	—
16/5/28 ..	49	3	1	10	31	—	4	38	—
23/5/28 ..	32	—	—	12	24	—	1	43	—
30/5/28 ..	69	2	—	18	8	—	19	24	—
6/6/28 ..	45	2	—	21	6	—	11	5	—
13/6/28 ..	92	2	1	50	8	—	19	12	—
20/6/28 ..	36	1	1	65	2	3	13	1	2
28/6/28 ..	30	2	—	17	1	1	2	—	1
5/7/28 ..	49	—	4	9	—	5	5	—	3
12/7/28 ..	29	—	3	12	—	4	4	—	—
17/7/28 ..	23	—	1	21	—	1	14	—	1
24/7/28 ..	11	—	1	8	—	—	12	—	1
31/7/28 ..	9	—	2	7	—	—	8	—	2
7/8/28 ..	10	—	1	6	—	3	11	—	—
14/8/28 ..	8	—	3	3	—	1	4	—	—
21/8/28 ..	6	—	5	7	—	—	2	—	—
28/8/28 ..	7	—	4	9	—	—	7	—	2
5/9/28 ..	—	—	No collection				—	—	—
12/9/28 ..	—	—	No collection				—	—	—
19/9/28 ..	12	—	1	9	—	—	6	—	1
26/9/28 ..	19	—	1	13	—	—	10	—	1

Stainer (*Dysdercus* sp.).—These insects were early observed in the early-planted cottons, and from then onwards families could be found throughout the season, but the really heavy immigrations did not occur till early in June. The infestation was fairly heavy during the next two months, especially on the spacing experiment.

By the beginning of August there was a large decrease in numbers, followed by a second, but much less severe, infestation in September. Traps of whole cotton seed were tried, but seemed to be of little value in attracting the insects. Crushing the seed was not tried, but in view of the extent of the damage caused by this pest, it is felt that a scheme of trapping would be valuable if a sufficiently attractive bait could be provided for the insect. A more hopeful method may be that suggested by E. Ballard and M. G. Evans [(*Bull. Ent. Res.*, xviii., **4**, p. 405) (*E.C.G.C Review*, October, 1928, p. 349)], of providing " suitable moulting places for the gregarious 5th instar nymphs."

In discussing the Variety Trials (p. 236), it was pointed out that the loss from flowering to boll opening was only in part attributable to bollworm, the remaining loss being accounted for by stainer. The difference for the three varieties ascribable to this latter cause shows the loss to be substantially less in the case of Strain V of Nyasaland Upland. This strain is of tall open habit providing much less shade, and field observations showed that this strain and Strain H, which is of somewhat similar habit, showed appreciably less bollrot than Strain G in the same field.

Jassid.—Jassid had been observed on the Station in the previous season, but the attack reached a much greater intensity this year, due in great measure to the presence of susceptible strains which had been sown early.

By the middle of March nymphs were first observed in numbers on the January 1 and 15 plantings, and the plants (Strain G) quickly showed the characteristic curling and reddening of the leaves. The attack rapidly spread to the adjoining plots with the effect of catching the standard plots of the experiment (planted on February 18) when the plants were about four weeks old. These rapidly lost their leaf and never recovered to any extent. The March 1 planting was next in extent to suffer, and in this case for the first time the standard showed a yield superiority over the plot in which the best time of planting was being tested.

The March 15 planting and its standard were noticeably less affected, being farthest from the original source of infection, but here again the youngest plants suffered most. Table 11 (p. 246) gives the yield obtained from this series of plots; all are very low, and

demonstrate the possibilities of the pest as a limiting factor in cotton yield where conditions for its development and spread are suitable.

TABLE 11.

Plot.	*Yield (lbs.)*	*Acreage.*	*Equivalent Yield per Acre (lbs.).*
Standard (February 18) ..	10	8 plots of $\frac{1}{40}$ acre	50
January 1 planting ..	21	„	105
Standard	14	8 plots of $\frac{1}{40}$ acre	70
January 15 planting ..	30	„	150
Standard	31	8 plots of $\frac{1}{40}$ acre	155
March 1 planting	22	„	110
Standard	42	8 plots of $\frac{1}{40}$ acre	210
March 15 planting ..	35·5	„	177

This same cotton strain, in fields not in close proximity to this and sown on February 18, gave yields up to 800 lbs. of seed cotton per acre. Further, on estates where this cotton was grown as a late-February-planted crop, it gave good yields and showed little evidence of jassid attack. It is evident that the effectiveness of this pest is determined, not only by the presence of a susceptible variety of cotton, but also by the presence of a centre of infection, in this case early-planted cotton, and the stage of growth of the plant when attacked. It was observed this season that even normally resistant types, An-12/2 and Z.1, showed considerable evidence of attack owing to their comparative closeness to the early-planted plots.

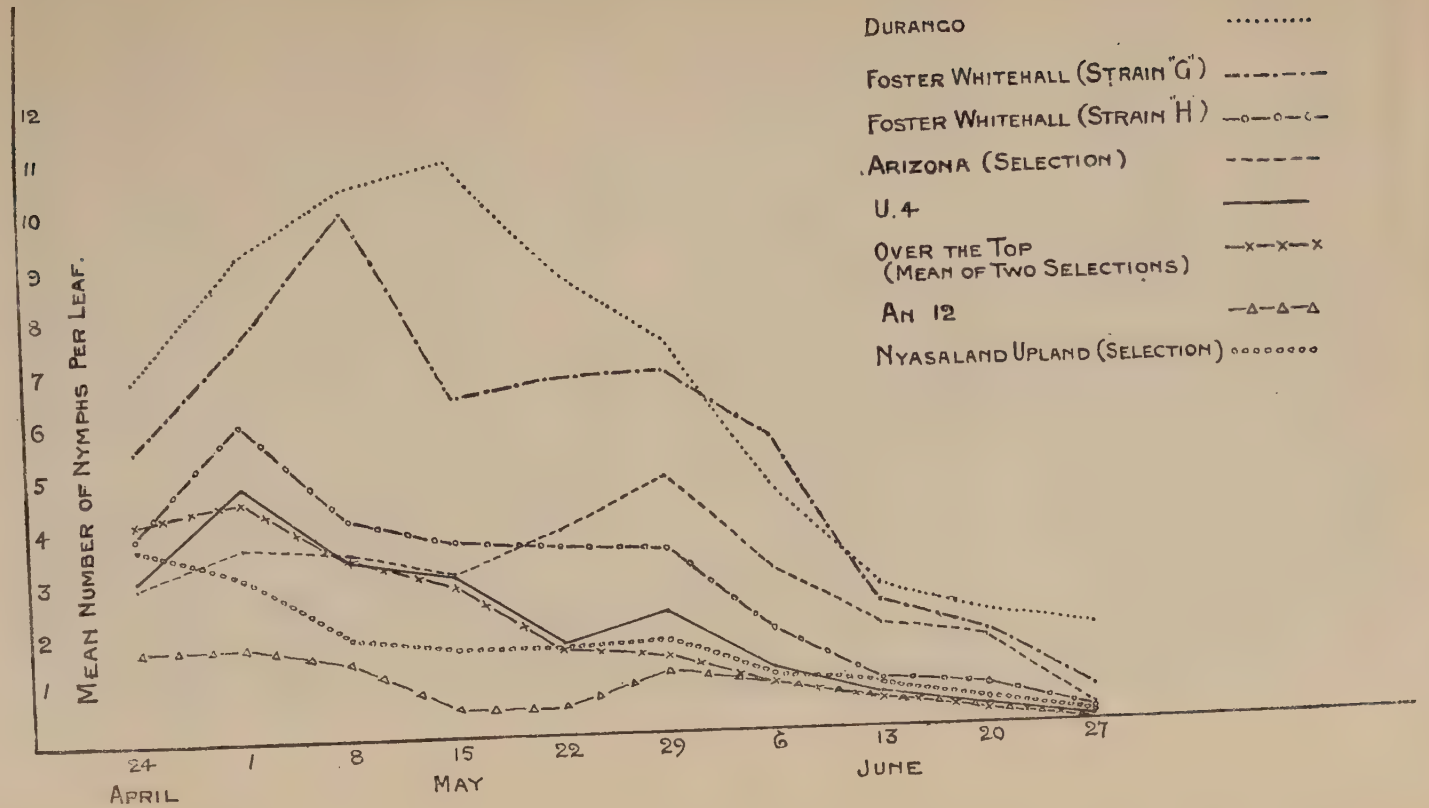
The selections in the breeding plot were put to a very severe test owing to the concentrated attack, and the task of discarding susceptible types was facilitated. Counts of jassid nymphs were made weekly on various strains in the breeding plot, and Fig. 5 shows the mean number of nymphs per leaf—counts being made on five leaves each of 10 plants per strain. All are from plants sown on the same day.

Durango was almost a complete failure; by the middle of May it was almost entirely defoliated. Strain G showed a heavy infestation, which was general also throughout its progeny rows. This strain will be discarded, and no further selection work done with it.

Strain H was just on the border-line of safety, but as the plants showed considerable variations in resistance, some of the best have been carried on and may provide an adequately resistant sub-strain.

Of the others, Cambodia selections showed no evidence of attack,

FIGURE 5. WEEKLY COUNTS OF JASSID NYMPHS ON VARIOUS VARIETIES
TWO GROUPS OF FIVE PLANTS EACH — FIVE LEAVES PER PLANT



while An-12/2, U.4/5, Z.1, and the Over-the-Top selections all showed a high degree of resistance.

It would appear that in this area, given conditions favourable to this pest, jassid may be a limiting factor in cotton cultivation, and one of the main aims in the breeding work will be the selection of jassid-resistant types.

Miscellaneous Pests.—*Oxycarenus* sp. was present in the cotton from July onwards in considerable numbers, while earlier in the season a fair amount of damage was caused by a "Stem Girdler." A small amount of leaf eating and leaf rolling was noted early in the season, but was of very minor importance.

Rotation Crops.

The season just completed has been an unfavourable one as far as the food crops were concerned. The lack of rain at the end of December delayed thinnings, and the hot dry periods in February and March greatly reduced the yields.

Macheweri (*Pennesetum typhoideum*).—Two varieties, an early and a late maturing one, were grown in bulk. The early type, which is relied on by the natives in this district as an early food crop, suffered greatly from a dry period just at heading and the yield was very poor—226 lbs. per acre. The later variety was much more productive, but compared with previous years the yield was very low, 713 lbs. per acre.

Mapira (*Sorghum vulgare*).—Two varieties were grown in bulk; both suffered from the lack of rain in the early part of the season, and yields were poor.

Groundnuts (*Arachis hypogea*).—Two areas were planted with the Spanish bunch variety and, though in appearance the crop seemed to wilt badly in the dry spells, good yields were obtained—1,200 lbs. per acre of unshelled nuts in one field and 1,500 lbs. in the other.

Cowpeas (*Vigna* sp.).—This was planted about the end of February and gave a good stand. Growth was good, but the crop was a complete failure owing to the drought conditions during the fruiting period and to the attack of insect pests.

Nandolo (*Cajanus indicus*).—In the previous season this crop had proved itself a valuable cover crop and an excellent yielder. Good stands were obtained this season, but owing to the dry season it did not make good growth and the yield was much smaller.

Bush Lima Bean (*Phaseolus lunatus*).—This has proved a very successful addition to the rotation crops of the Station. Planting was done in December, the seed sown 6 inches apart in 3-feet rows,

and a second planting made in March between the rows. This double planting proved a successful practice, and in spite of the droughts experienced by the crop a fair yield was obtained.

Sunn Hemp.—As in previous years, the seed was broadcasted and germinated well, but growth was not very good. Owing to an enormous infestation by a Lygæd bug, which punctured the young pods and destroyed the developing seed, little seed was harvested, the yield being barely equivalent to the seed rate.

In addition to the above a large number of potential rotation crops were grown in small plots. The cereals gave nothing of particular value, but several of the pulses were promising, particularly Green Gram (*Phas. Mungo*) and two species of Canavalia obtained from the Imperial College of Tropical Agriculture. The Canavalia, though planted rather late, proved to be an excellent cover crop. The Green Gram yielded well, and on account of its quick maturity it is greatly in favour with the natives.

A purple-leaved type of *Dolichos lablab* obtained from the Imperial College of Tropical Agriculture was much superior in yield to the local types, and appeared to be less attacked by insects.

REPORT ON ENTOMOLOGICAL WORK ON COTTON, SEASON 1927-1928

BY

C. B. R. KING.

Introduction.—Work on the control of the Red (Sudan) Bollworm carried out in 1927 showed great promise in the direction of trapping moths by light. Experiments were therefore made this year to confirm this and to develop, if possible, some scheme that was simple to work. At the same time observations were made on both Spiny and American Bollworms.

The problem of the Stainer still remains acute. Although a great deal is known about its life history, no satisfactory control has been found up to now, but, nevertheless, certain possibilities present themselves.

Red (Sudan) Bollworm (*Diparopsis castanea*).

According to observations made in previous years, the moth does not begin to oviposit on the young cotton before the squares begin to show, and it was, therefore, intended to start to trap when the cotton was five or six weeks old. Nyasaland Upland was chosen this year, the seed being obtained from the B.C.G.A.'s ginnery at Chiromo, and it was planted on December 12 and 13 over 5 acres. The larger plants began to show squares on January 24, and, accordingly, the traps were started that night. The weather since the middle of December had been very dry, no rain falling for five weeks, and moths and other insects were very few.

The Light Traps.—The light unit used in the experiments was a modification of a cheap pattern of an acetylene hand lamp in which the carbide container fits loosely into a cylinder containing water, the water port being a fine hole at the bottom of the carbide container. The modification consisted in lengthening the horizontal pipe outwards by about 12 inches, the end being fitted with a brass connection having two jets and a tap. The two jets give approximately 100 candle-power. The water tray consisted of a 2 feet square piece of galvanized iron with a 3-inch turn-up. This was half filled with water and a film of paraffin allowed to form on top.

The Traps in Action.—In 1927 a single jet of acetylene of about 50 or 60 candle-power was found to have a non-working period of about a week a month, corresponding to the second week of the moon. This year a two-jet light was first used, giving about 100 candle-power, and the period was shortened to three nights a month. Afterwards the light was doubled and the bright period of the moon tided over, bollworm moths being caught every night. As the activity of the moths, especially females, is greatest just after dusk, it was considered that if the light burned for four or five hours it would be sufficient; and so it turned out.

It would thus appear that a 200 candle-power light (acetylene) is about the minimum economic strength for Red Bollworm moths on account of the moon; and this value will suffice for about ten acres, provided the area is more or less square; in other words, the range of attraction is about 130 to 150 yards.

Sensitiveness of the Red Bollworm Moth to Light.—Repeated observations show that this moth is very easily attracted to light. It has been known to come to candle light, ordinary wick paraffin lamps, paraffin vapour lamps, electric light (ordinary vacuum metal filament lamps) and acetylene light. The opinion amongst many entomologists would seem to be that acetylene is of little value for attracting insects; but there is no doubt that it works quite well with regard to a number of different insects. It is very possibly true that it is not the best light to use to get maximum attraction for minimum power, and it is hoped later to be able to test the values of different light sources in this connection. At present, extended trials are about to be made with acetylene only, as this light has unquestionably shown itself to have the power of attracting both females and males, and, moreover, the females have invariably been gravid. Parsons (*v.* p. 77) states that ordinary wick hurricane lamps exert a strong attraction on the moth, and I have confirmed this. If the light trap method of control becomes established, it will be chiefly a consideration of strength and range of attraction.

Results of Trapping in 1928.—Finding that hand-collecting moths ceases to be of maximum value when the cotton plant begins to get fairly bushy, a state coinciding with the period of maximum emergence, it was decided to dispense with it altogether this year and to depend on the light trap alone. The result was extremely encouraging.

Owing to a five weeks' drought after planting, insect activity was strongly curtailed during the latter part of December until the end of January, when about 6 inches of rain fell in a few days. Large

numbers of insects were caught during and after the rain, but only three *Diparopsis* were caught in the trap and two by hand. After this, until February 10, no rain fell, and there were no signs of bollworm moths. The cotton was, by this time, budding freely, yet there were no eggs or flared squares to be seen. On the 11th an inch of rain fell, and after this a few moths were found in the trap, six males and three females being captured in the second half of February. In March captures became general, and there was considerable activity in April also. The rains continued rather late, and some bollworm moths were captured up to May 9. After this the trap was discontinued owing to lack of carbide, but this did not matter, as a quantity of cotton had by now opened and been picked. Also Stainers were multiplying and young bolls getting stained.

A little over two tons of seed cotton were picked from the 5-acre plot, which, considering the stand was 50 to 55 per cent., is considered satisfactory.

Cost of Trap.—The capital cost of the two lamps used was £2 5s. They are well and strongly made and should last many years, the only parts requiring occasional renewal being the burners. The total cost for the one year is therefore:

	£	s.	d.
Lamps	2	5	0
3 cwt. carbide	8	4	0
Labour at 5s. per month	1	0	0
	£11	9	0

—*i.e.*, £2 6s. per acre approximately.

It is highly probable that this light would be sufficient to control 10 acres, as the 5-acre block was about twice as long as broad, and if that is so, the cost per acre would be halved.

The Catch.—The number of moths caught during the season was 244, consisting of 158 males and 86 gravid females, distributed by the month as follows:

Month.	*Males.*	*Females.*
January (last week)	—	—
February	6	3
March	85	55
April	58	22
May (first 8 nights)	9	6

About twenty of the above moths were taken by hand, not in, but within a hundred yards of, the cotton. Now, after emergence, the moths usually rest on the nearest plants and later fly into cotton

if the scent or other attraction is strong enough, therefore it is unlikely that these moths came out of the cotton, or that they came from elsewhere and alighted, not in the cotton, but some way from it. The inference is that they emerged in the neighbourhood of the place where they were seen and caught; and it is to be noted that in 1926 there had been a plot of 10 acres of cotton in the same place, with a blank year in 1927. Thus the impression received is that the insect can last over a complete year in some resting state, larval or pupal, to emerge the season after. This is strengthened by the occasional long pupal periods, up to nearly two years, noted by several observers. Therefore a trap light, besides giving a measure of economic control, can be used as a method of determining some of the points connected with the bollworm's seasonal history.

Further Data on Seasonal History in Nyasaland.—Besides the emergence of probably long-cycle moths referred to above, another interesting point is revealed. Apparently the normal emergence of moths is as follows: First, an emergence in November or December, due to the first rains, consisting largely of males. Then a falling off, gradually increasing until the maximum period is reached about March, after which it falls away again. Now it has commonly been supposed that there is more than one generation in a season and that a second generation at least makes its appearance about March. Trapping, however, shows that this is not the case. As the moths came out, so were they trapped, showing a very effective control, as very few bollworms were observed during the season. Yet the number of moths increased as usual, so that one is forced to the conclusion that there is really only one generation of importance during the critical period—namely, the rainy season—and that it extends over the whole of it. This would rather indicate that the close season enforced by law may not be so effective as one has hoped and that, in fact, ratoon crops, if properly controlled and cut back at the right time, might actually be an economic proposition. But, at the same time, one cannot but admit that such a practice would be dangerous if left to natives. One of the chief benefits conferred by ratooning is early maturity; and if moths were trapped in the manner suggested above, the crop would probably be able to ripen before the Stainers had a chance to do much damage.

American Bollworm.

As usual, the American Bollworm made its sudden appearance towards the end of February, and the attack lasted some three weeks. Only a few moths appeared to be attracted at first—*i.e.*, to the

100 candle-power light—but when this was doubled they were caught more freely, both males and females, some of the females being gravid. It may be that the strength of the light is an important consideration in regard to gravid females, and this point will be particularly investigated during the 1928–29 season, when much more powerful lights will be tried out.

Spiny Bollworm.

These pests made their appearance at the beginning of the season, but did not do much damage. Their appearance at the light trap was erratic. Sometimes, when there were numbers seen in the field in the evening, none would be found in the trap; at other times, although hard to find in the cotton, several would be caught at the light. About equal numbers of the sexes were caught, some of the females being heavily gravid and some spent.

Parasites.

There are reports of more than one egg parasite of the Red Bollworm from South Africa, but the percentage of parasitism is low. It would probably be well worth while, if the history of these is worked out, to find out the length of the cycle and whether there are any hyperparasites; in that case it might be possible to introduce an egg parasite into Nyasaland with benefit to native growers. The problem is a big one and, moreover, would need the whole-time services of an entomologist.

It has often been urged by entomologists that light trapping may do more harm than good by luring to destruction useful parasites. Beyond the mere expression of opinion I have seen no record of experiments carried out to test this contention. However, as pests may do a great deal of damage in spite of parasitism and other forms of natural control, any measure, however artificial, which can improve economically on the checks offered by Nature must be worth while.

Stainers.

These insects made their appearance towards the end of February, which season seems to be fairly regular every year. Seed traps had been placed in readiness about the field, and some numbers were caught, but it seems impossible to do more than trap a proportion, the remainder always being sufficient to stain a good part of the crop. On a large scale, this method would not seem to be practicable. The stainers disperse too easily on immigration and are not attracted very strongly to the seed, unless they happen to alight fairly close to

it. At present the best policy would seem to be to aim at trying to get the cotton to mature early, before stainers become numerous, and this may be done by: (1) Selection of early maturing varieties; (2) early planting where possible; (3) ratooning.

The natural enemies of stainers are quite insufficient to cope with them. *Phonoctonus*, a Reduviid with a striking likeness to Dysdercus, appeared in larger numbers than usual, but did not appear to act as a check to any extent.

NIGERIA

REPORT ON THE CORPORATION'S SEED FARM, DAUDAWA, NORTHERN NIGERIA, FOR THE YEAR 1928

BY

G. BROWNE.

Recapitulatory.—The farm was started in 1926 with the object of assisting the Agricultural Department in the mass multiplication of their selected cotton seed. The site selected covers 1,280 acres, and the situation is at Mile 60 on the road leading from Zaria to Sokoto. The bush is fairly dense, with an estimated timber content of some 220 tons to the acre.

Clearing was commenced in February, 1926, and, as stated in last year's report, the following were the crops in that year:

Cotton, 40 acres; Beans (Dolichos and Maicuna), 50 acres; Ground nuts, 10 acres; Guinea corn, 20 acres .. .. Total 120 acres.

The cotton over the 40 acres averaged 300 lbs. of seed cotton to the acre. Nine bales were produced, the brokers' report on which read $1\frac{1}{8}$ inches full, rather soft, but freer from nep than average Nigerian (150 points on). The ginning outturn was 29·73 per cent. lint.

In the season 1927–28, the farm had grown to 220 acres, cropped as under:

Cotton, 100 acres; Beans (Maicuna), 102 acres; Lubia, 5 acres; Guinea corn, 10 acres; Ground nuts, 3 acres .. Total 220 acres.

The cotton over the 100 acres averaged 400 lbs. of seed cotton to the acre, and amounted to 28 bales. The staple was again $1\frac{1}{8}$ inches, and the value 13·45d. per lb. (150 points on). The colour, however, was said to be "creamy." The ginning outturn was between 29·19 per cent. and 30·8 per cent. lint.

This season, 1928–29, the crops are as follows:

Cotton, 170 acres; Beans (Maicuna) 100 acres .. .. Total 270 acres.

(No Ground nuts or Guinea corn were sown this year.)

While progress may not appear to compare well with last year so far as clearing and breaking new land is concerned, it has, on the whole, been quite satisfactory.

Clearing.—Fields 12 (20 acres), 14 (10 acres), 17 (13 acres) have been cleared and put under cotton. The two latter are not yet complete—all fields on the farm have a uniform size of 20 acres.

The method employed in clearing consists, as before, in digging round a tree and, at a distance of some three feet, cutting the lateral roots. When this has been done, a rope is thrown over a branch as high as possible, and the tree pulled to the ground, where it is "boughed," cut into sections and carried away. The tops and small stuff are burnt, while the big pieces and boughs are piled for use as fuel for the steam engine and hot-air pumping engines. Even so it is found that the lateral roots are constantly springing up, and men have to be put on to clear the suckers away with a digger. The holes where the trees have been are then filled up roughly, and the ground is ready for cultivation.

Cultivation (*Breaking land*).—The above-mentioned fields were broken on a new system, which saves both time and money. In previous years after clearing new land, gangs of men were employed in breaking the whole surface of the ground. This work, though very effective, was most expensive. This year the cleared fields were pegged out along each end with the number of rows or ridges required. (The fields are 440 by 220 yards.) At convenient distances (in this case 40 yards) other pegs were driven in parallel to the first and equidistant. Gangs of men came along, the first with light ropes which were stretched between the pegs; another gang ran along the rope with a coloured earth or wood-ash which contrasts with the colour of the grass or the general surface colour, and the next gang broke the surface with *Patanias* or hoes along the lines so marked. When this had been done, the men who made the ridges with the native hand plough, or *Galma*, ridged up the earth from each side on to the hoed portion. This form of ridge, therefore, has the advantage over the ridges made by native farmers, in that the ground underneath is broken and gives the root system a chance to get into the ground. While this method is a great improvement on that of previous years, as regards both time and expense, it is thought that it could be improved on still further if the land so broken were allowed to lie fallow for a time in order that the heavy rains could act on it and consolidate it a little by washing the soil into the interstices before the sowing; but the practical difficulty in a country like Nigeria is that the season when the ground can be worked easily is limited. This practice also has the great advantage of combining the two operations of breaking and ridging. The plants growing on these ridges do not, at the time of reporting (mid-September), appear to differ from the others.

Crops (*Cotton*).—The whole of the Daudawa seed of last season's crop that was suitable for distribution was placed at the disposal of

the Department of Agriculture. It amounted to 26,100 lbs., and was issued by them. This year the seed sown on the 170 acres under cotton was again Maigana No. 1, with this difference, that this supply came from the Agricultural Department's farm at Samaru, where it formed last year's main crop. It originated from selections made at Maigana in 1923-24, where it was bulked and subsequently grown as the main crop. It was tested against the Government Botanist's strain at Samaru and at Bomo in the past two seasons, and gave rather better yields than the other strains tested against it.

Planting was commenced on June 18, 1928, and finished on July 21. The work was done this year again by women and children, who have improved a little on last year, but are still far from accurate in their spacing and the amount of seed per hole. They also did the resowing and thinning. The amount of seed required for resowing was not great, as germination was very good. The plants were thinned to two per stand as formerly. The ridges were 4 feet apart, but next year a reduction to 3 feet 6 inches or 3 feet will be tried. The appearance of the cotton as a whole is excellent, although the later-sown plants are suffering from leaf roll and crinkle owing to the exceptionally wet and dull August. With the increased sunshine of September it is hoped that it will pull up again, and in any case this trouble is confined to a very small part of the whole area. Flowering seems to be much heavier than in previous years, and started on July 24, or about the sixth week after the earliest sowing. The crop looks very even in both stand and colour, with the exception of that in Field 7, which had yellowish patches in it. This was either due to a sourer subsoil coming to the surface, or else it was where the heaps of wood had been burned three years ago. The cotton is now regaining its normal colour.

Beans.—The Maicuna beans this year are very good. Sowing was started in the third week in April, and the crop was very luxuriant by mid-September, in many places being matted to a depth of 3 feet. In the second week in August turning in for green manure commenced, the procedure being as follows: men first went between the rows with knives and cut the tendrils, after which others followed and, by a sideways twisting movement, wound the beans into a ropelike formation. The ridging gang then covered them up, and they will lie fallow until next season's cotton planting, when a light dressing will be all that they will require. The men who do the twisting become very expert at the job, and go along almost at walking speed. It has been found that to turn the beans in after the rains is most difficult, and that to plant early and turn the beans early saves

considerable expense. The cost of this operation this year has been a mere fraction of what it was in the first year, when the work was left until October. The result is well worth any additional trouble, for the extent to which the ground benefits is enormous, so much so that some of the fields which have carried cotton this year will take a second crop next year without any fear of impoverishment. Seven acres of beans have been left for seed. These are more than are likely to be required for Daudawa, but the Agricultural Department were glad of some seed last season, and will probably like to take any surplus that there may be.

Labour.—Throughout the dry season labour was plentiful, but never actually too much, as it is regulated by our labour recruiter. With the rains the supply fell away, as men began to drift back to their own farms. The number who have stayed on the farm is, however, greater than last year: in other words, the permanent labour staff is steadily increasing. A fair number of soldiers have come, some of whom have stayed, but others have found the work too hard. The *Galma* (hand-plough) is the worst kind of work, from their point of view.

There has been some difficulty in housing the labour staff as the rainy season caused several grass houses to collapse, and although, before the rains, some twenty-five houses were replaced by semi-permanent ones with mud walls and thatched roofs while good grass was available, there may be a shortage of houses when the labour supply begins to increase again, and some huts of a temporary nature will probably be necessary. Another factor is that more men are bringing their wives to Daudawa, which means one house to each man, and though this development is highly desirable from the point of view of forming a permanent labour staff, it reduces the number of houses available for single workers. In the coming dry season it is proposed to guard against a recurrence of a shortage of housing by building a rick or stack of grass ready for re-roofing and rebuilding.

Guinea-worm has again taken a big percentage of men-days, but it is hoped that with the new water supply this will gradually die out.

A new departure regarding labour has been the institution of contract work. The men like it and finish their work much earlier. It is also advantageous to the Station because more work is done per man per day, and it is possible to foretell what the labour costs will be. Close supervision, however, is necessary. Contract or task work is not applicable to all descriptions of cultivation, such as clearing, but for ridging, weeding, etc. it is most satisfactory.

During the winter, rice and guinea corn were bought in bulk and

retailed at cost, which, together with the water supply, was partly responsible for keeping the labour on the estate.

Cattle.—In March, 1927, two men were sent to receive instruction from the Agricultural Department on working with cattle. Owing to tsetse fly, however, our cattle did not arrive at Daudawa until more than a year later, and by this time the men had forgotten all they had ever learnt about handling and ploughing with them. It was then too late to re-train them at Daudawa, where the staff were very busy preparing for the cotton planting, and as the Agricultural Department wanted and could make use of the cattle at Samaru, they were lent to them. Later on the Department have kindly promised to lend Duadawa a ploughman temporarily in order that another trial may be made.

The Egyptian ploughs to which the cattle were yoked seemed to work satisfactorily; one was fitted with breasts, and it turned the soil over well.

Cattle Kraaling.—About one hundred Fulani cattle grazed on the farm for some two to three months. They spent the days on Fields 2, 3, 5, 7, 8 and 11, the night kraal being on Field 6. The water supply was a considerable attraction, as well as the food, and the good grass on which they fed their cattle.

Mechanical Cultivation.—Through the kindness of the British Cotton Growing Association, a partial test of mechanical cultivation has been carried out. The Association lent a Fordson tractor for which land wheels were sent out from England by the Corporation, as were also a two-furrow disc plough, a cultivator and breast plough combined, and a set of harrows, all made by Ransomes, Sims and Jefferies, but it was impossible to get them out in time for an experiment on anything but a small area. The plough went through the dry earth very easily, and also cut many of the lateral roots, and it undoubtedly turned the soil over in a way that could never be achieved by hand cultivation. Whereas by hand it is difficult to maintain an even depth of about 4½ inches, the disc plough would take up to a foot, if necessary. The ploughing was followed by harrowing, but again the short time available rendered an extensive test impossible. Finally 5 acres were ploughed with the disc ploughs, but owing to trouble with the breast plough, only 2½ acres were completely worked by mechanical means. The other 2½ acres were hand ridged, and will serve as a comparison. The 2½ acres which were completed could not be described as having been thoroughly worked, nor was it a fair test as regards cost.

Windbreaks.—It still remains to be determined whether wind

breaks are of real advantage to fields of fairly large acreage. This year some 1,800 seedlings have been planted in breaks running lengthwise of the farm. Unfortunately to give the best protection from the prevailing wind, they should be placed diagonally, which is naturally impossible. The trees are Eucalyptus and *Dalbergia Cesa*, with a preponderance of the latter. They are planted in straight lines at 10-feet intervals, and staggered.

The Ginnery.—Last year's cotton crop, with the exception of 1,300 lbs. sent to Funtua for a separate test of ginning outturn, was ginned at Daudawa. This amounted to 41,065 lbs., and the lint amounted to 11,142 lbs. In a ginning test of 300 lbs. carried out at Daudawa, the percentage of lint was 30·8, which is satisfactory. The work was carried out without a hitch, though the hand press proved a little slow for the gin, and was apt to cause delay at times. The Robey steam engine works smoothly and economically, and does efficient work with the minimum of attention. The circular saw is invaluable for providing fuel for both the Robey engine and for the hot-air engines used for driving the water pumps. At present an outside tank is in course of construction for the Robey engine, in order to keep the inside tank at a constant level at all times. This new tank will be fed from the eaves during the rains, and in the dry season by the water supply.

Waterworks.—A pumphouse has been erected by the river and houses two hot-air engines, which pump the water up to the house and from there to the farm, besides supplying the village and the ginnery. The fuel for these is timber cut up by the engine and circular saw on the farm, and the engines are worked by a native from the farm who showed some mechanical aptitude when helping with them. While a hot-air engine is ideal from the point of view of fuel and labour requirements, it cannot be said to work more than moderately well. Repairs have been needed more frequently than should have been necessary, and the root cause of the trouble has still to be determined.*

Buildings.—The pumphouse was of necessity somewhat costly, as it had to be built throughout of the best materials, with very deep foundations, to withstand the heavy floods in the rainy season. It is built on arches which allow the water to pass underneath. Between it and the river is the sump or well, which the water reaches by way of a series of filter-beds, but which unfortunately are non-effective in the rains.

The first staff house was re-roofed, and at the same time the

* It is possible that some of the efficiency of these engines is lost owing to the high temperature of the atmospheric air which enters the engine.

walls were raised 18 inches all round. The houses for co-operating farmers were built partly of stone and partly of mud. These buildings are not altogether satisfactory, as they are too dark, and a new type is to be tried this year which will be a little less expensive. A store for spare parts and a small kit store have been built adjoining the garage, thus saving a wall in each case. Owing to borers and hornets eating the timber supporting the roof of the garage, it had to be taken out and replaced by iron rails and old pipes, by which means it is hoped that it has been made permanent. Altogether twenty-five new houses were built for the labour lines, nine for the native staff, and one for the pumphouse attendant. These new houses have mud walls with palm rib framework for the grass roof, instead of the bush timber and grass matting previously used; it is found that white ants and borers devour the timber, with the result that when the rains come the house collapses.

Co-operative Scheme.—In the last Annual Report the co-operators' farms were in crop, but houses still remained to be built. These have now been erected, and these farms are in complete occupation. The farms are of 10 acres each, made up as follows: 5 acres uncleared bush, 4½ acres cleared and cultivated land, and half an acre for a steading. Last year they had an excellent crop of cotton, averaging, on the first farm, 365 lbs. seed cotton per acre, on the second 341 lbs., and on the third 312 lbs. per acre. The farmers were paid for their seed cotton at the highest local price, and it was ginned with that from the main farm (being from the same seed) and sent to England for sale. This year they have had a very good crop of *Gero* (bulrush millet), and a good crop of guinea corn is coming forward. Their cotton, of which each farmer has 2½ acres, is looking well also. The farmers are anxious to follow the green manuring rotation adopted on the main farm, and a scheme for this has been evolved to start this year. Each man has a sum of money remaining in our care to his credit, although the year's cultivation is nearly over, and this is a healthy sign. They appear actually to *want* to save money, which is certainly unusual. Three more farms have been cleared on the same lines as before, and houses will be built in time for handing over when the farms are in full crop. For these new farms the three men who have been chosen include one ex-N.C.O. Further extensions are to be made this year, and there is little doubt that suitable farmers will be found for them.

Meteorological Notes.—As will be seen by the accompanying chart, last year's rainfall was abnormal, especially in the month of September. This year has so far been about an average year as

regards quantity of rain, but the number of rainy days to date has been above normal. Up to the time of writing (mid-September) rain has fallen on every day, with the exception of three days, since August 1. The incidence has been excellent, as there have been no large individual rains with consequent washing away of ridges.

March and April were very trying again, as were also October and part of November, 1927, to a lesser degree. The temperature on many days in April exceeded 100° F., and on one day reached 106° F. Some natives think the rains may finish early this year, but as yet there are no indications of it.

Cotton-seed Distribution.—The seed from the 41,065 lbs. of seed cotton put through the Daudawa ginnery amounted to 28,400 lbs. Of this 241 bags of 100 lbs. each were sent to Dan Ja, while 23 bags went to Bakori. In addition, 22 bags of imperfect seed were retained as not fit for distribution. This latter seed was from the dirty cotton which was ginned first, and it was kept for cattle feed.

From the seed sent from the Agricultural Department's Farms at Samaru for this year's sowing a portion was allocated for use by native farmers in the immediate neighbourhood, whose names and addresses were taken, as well as their estimated farm acreages. A clerk was sent to check the majority of these, and those farmers in the immediate vicinity were interviewed personally. The seed was issued at the rate of 16 lbs. per acre, but as some farmers came back for more it appears that this rate was exceeded. It is difficult to limit native farmers, who are under only partial supervision, to a given quantity; if they are instructed only to put a certain specified number of seeds per hole they are only too likely to spend all the time counting the seed, and so get nothing sown at all. Seed was issued to twenty-four farmers in all, whose average acreage was 3½. Seed thus issued amounted to 1,625 lbs. Several of these farms have already been visited, and what has been seen is good healthy-looking cotton, apparently planted at the right time.

Residential Site.—The trees planted last year have made great progress. All the seedlings planted on the farm windbreaks were grown here, and many seedlings of different kinds are coming along this year. An orchard containing orange, grapefruit, lime and paw-paw has been laid out. There are also banana-trees. A small quantity of Egyptian lubia (beans) was sown again as a garden plot, but failed. Another and larger plot of Lima beans gave better results, giving better foliage, and a good crop of beans is now in course of being harvested.

General.—The Assistant Director, Colonel French, and Mr. Engledow paid a visit to Daudawa in January. A conference was held at

which were present the Assistant Director, Mr. Engledow, members of the Agricultural Department, and the European staff of the Corporation. The result of this conference is contained in the Report issued by the Corporation on Colonel French's and Mr. Engledow's return to England.

In this locality there is decidedly more cotton planted than in the last two seasons. More applications for seed were received from farmers than last year, and each wanted more seed. Most of those to whom seed was supplied work at some time or another on the farm, and they have certainly not only tried to copy the methods there used, but they ask for sowing dates, and in many cases re-sow and thin at the same time and in the same way as on the Farm.

An officer of the Tsetse-fly Investigation has identified tsetse fly here. As a result of this, tracts of land on each side of the *Fadama* (stream bed), which runs across the Farm, have been cleared, with the permission of the Native Administration. These tracts are 100 yards deep on each side.

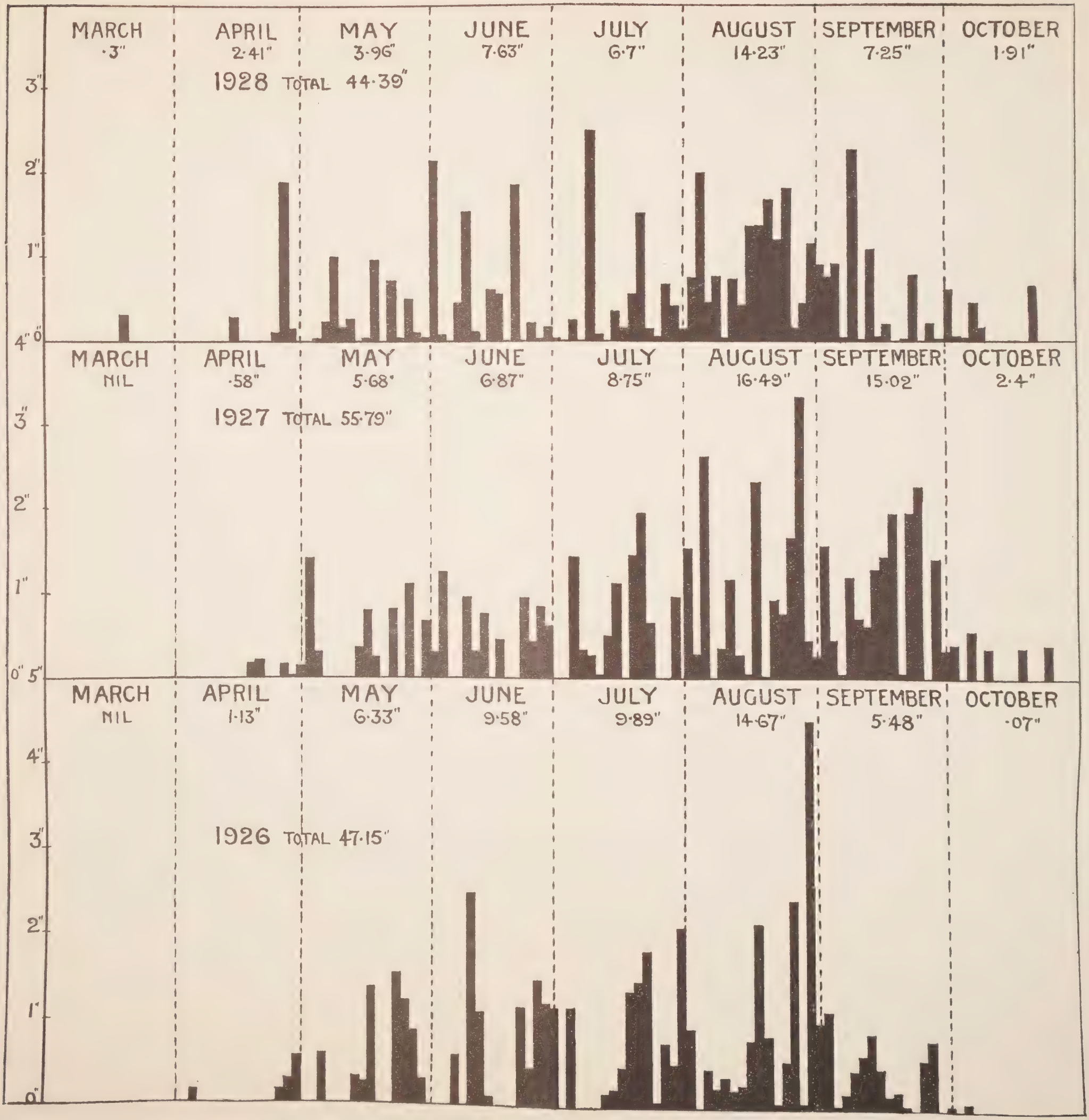
The health of the whole farm, European and native, has been good except for the guinea-worm, which unfortunately has laid many low for varying periods.

Total Area Under Various Crops.

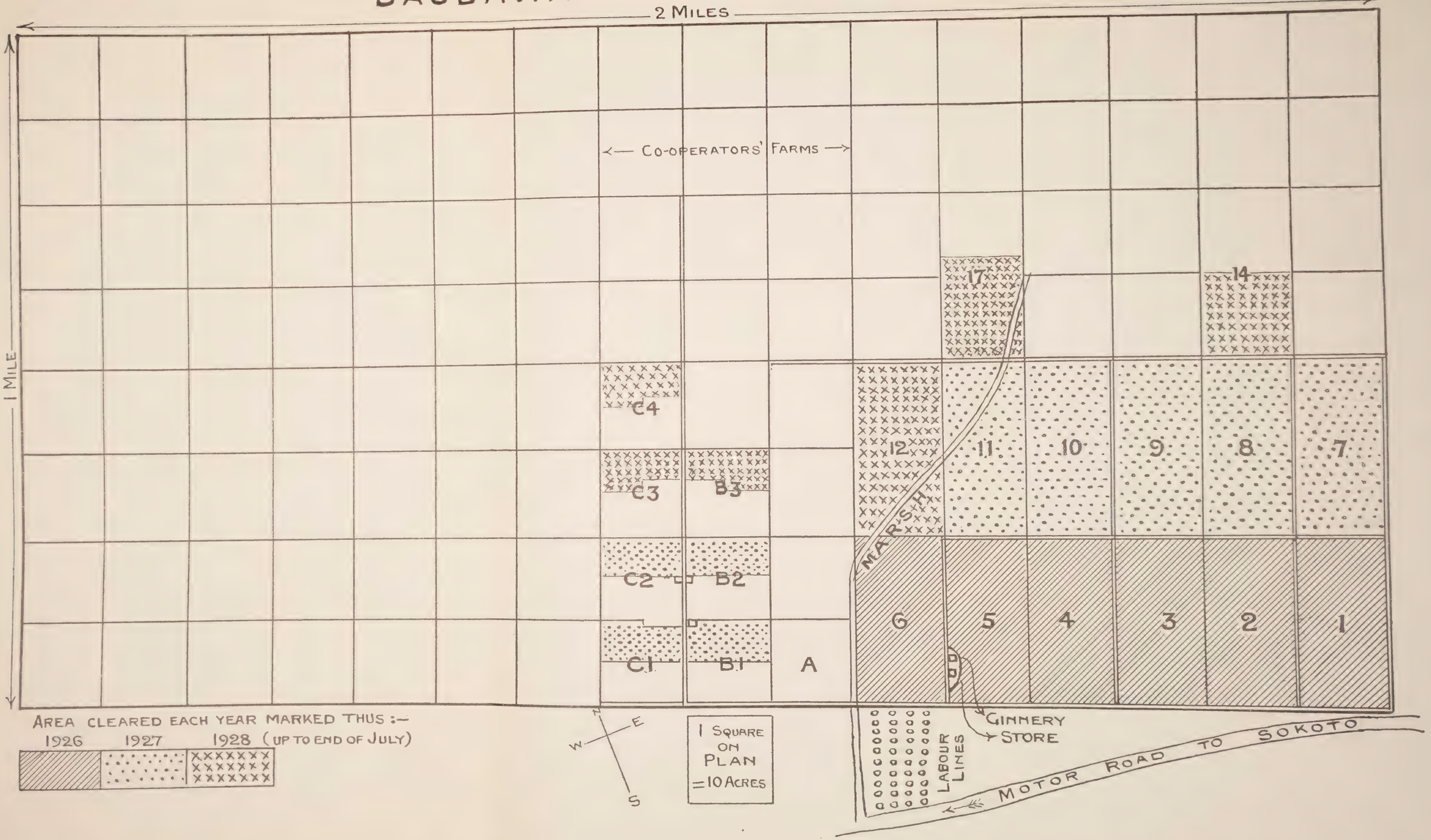
Field.	1926–27.	1927–28.	1928–29.	*Probable Crops* 1929–30.
1	Cotton	Beans	Cotton	Cotton
2	Beans	Cotton	Beans	,,
3	Beans and Corn	,,	,,	,,
4	Cotton	Beans	Cotton	,,
5	Groundnuts and Beans	Cotton	Beans	Beans
6	Beans and Corn	Groundnuts Beans and Corn	Cotton	Cotton
7	Uncleared	Lubia and Beans	,,	Beans
8	,,	Cotton	Beans	Cotton
9	,,	Beans	Cotton	,,
10	,,	,,	,,	,,
11	,,	Cotton	Beans	,,
12	,,	Uncleared	Cotton	Beans
13	,,	,,	Uncleared	Cotton
14	,,	,,	Cotton	Beans
15	,,	,,	Uncleared	Cotton
16	,,	,,	,,	,,
17	,,	,,	Cotton	Beans
	120 acres	220 acres	273 acres	340 acres

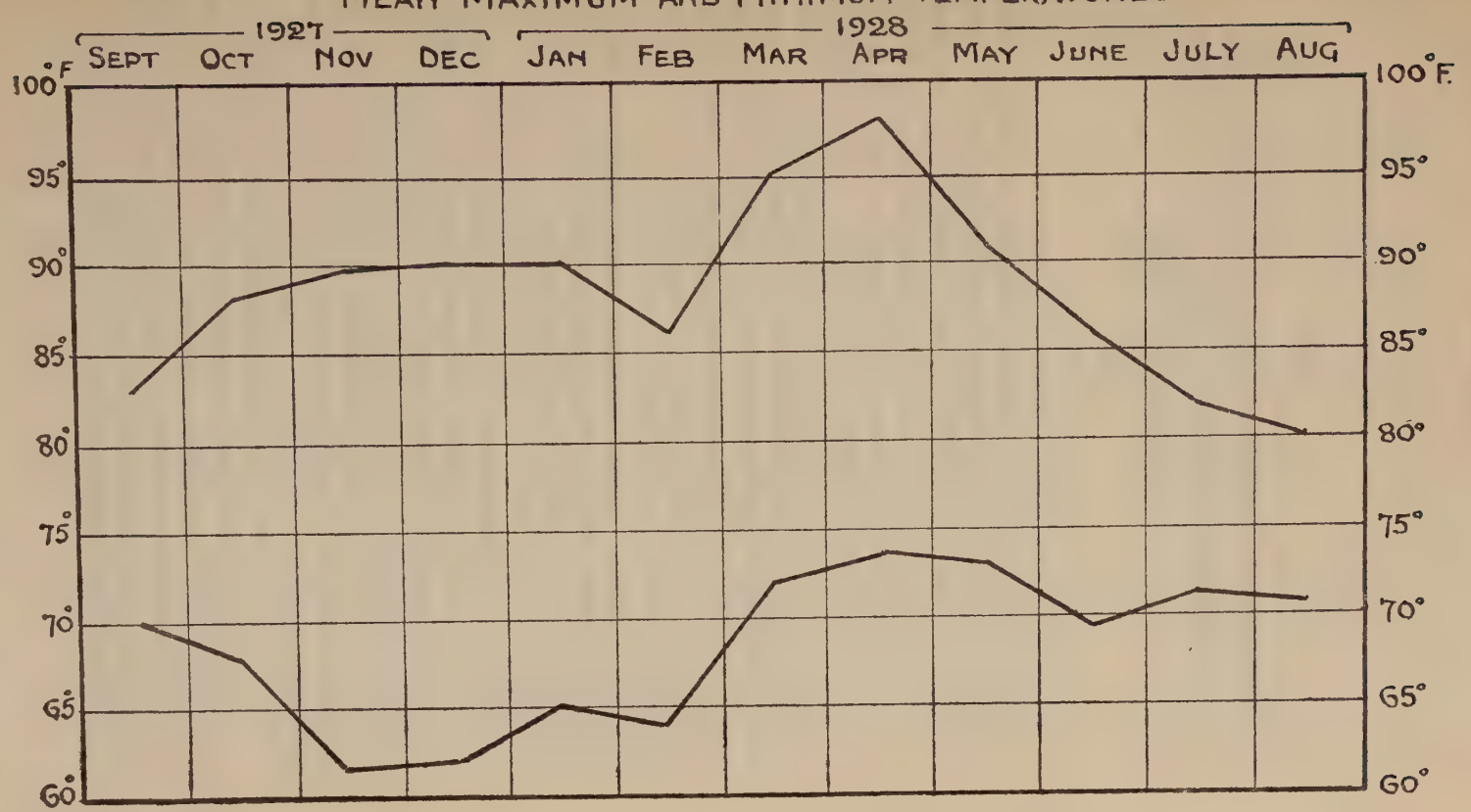
N.B.—Field 14 this year is 10 acres, and Field 17 is 13 acres. In the coming clearing season they will be increased to their normal size—*i.e.*, 20 acres. All other fields are normal.

RAINFALL AT THE CORPORATION'S SEED FARM, DAUDAWA, NORTHERN NIGERIA.



DAUDAWA SEED FARM 1927-28.




DAUDAWA, N. NIGERIA.
MEAN MAXIMUM AND MINIMUM TEMPERATURES.
1927
1928
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
100°F
95°
90°
85°
80°
75°
70°
65°
60°

FIJI

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATION, SIGATOKA, FOR THE SEASON 1927-1928

BY

R. R. ANSON.

During the past season the experimental work has been conducted on similar lines to those described in my report on the operations of the previous season. In order to provide adequate isolation for the "increase plots" of single plant selections, and to allow for crop rotation, it was found necessary to increase the area of the Station; an additional 134 acres has therefore been acquired. This area comprises 50 acres of flat land, which, although at present heavily covered with guava and other bushes, consists of light, friable river silt of great depth, and with fair drainage, and is first-class cotton soil. The remaining 84 acres consist of hill slopes, most of which are unsuitable for cultivation purposes. These will be used for paddocking the farm stock.

The total area of the Station has now been brought up to 166 acres, of which 80 acres are suitable for cultivation. This should greatly facilitate the economic working of the Station.

Season.—Continuous rains at the commencement of the season hindered planting operations, and many growers had their crops completely washed out, while others were unable to secure a good stand owing partly to the faulty seed beds, and partly to the continuous rains and relatively high humidity in the atmosphere which caused a large proportion of the seed to rot, and a poor germination resulted.

At the Station we were more fortunate, thanks to drains and a tractor plough, which enabled us to prepare and plant up fairly large areas in a short space of time, and to take full advantage of favourable weather conditions. In this way we managed to obtain an excellent stand throughout, before the heavy rains, which set in in February, lasted until May, and caused all varieties to put on an

abundance of wood and to grow lank and sappy. Some of the Kidney Hybrids and Tanguis cottons grew 10 feet high. It was decided to have these topped in order to check the growth, allow the sun to penetrate, and to facilitate picking. A sharp cane knife was used for this purpose and plants were pruned to a height of 5 feet. They were cut by an upward motion of the knife, care being taken to strike the branches just above a node in order to avoid mutilating them so far as possible. Although this somewhat drastic treatment considerably checked the growth, and caused plants to be later in reaching maturity, it had the desired effect, and turned a crop which would otherwise have been a decided failure into a moderately good yield.

The rains ceased suddenly at the end of May, and thus the later varieties reached maturity in favourable weather, which lasted for four months and added considerably to the ease of picking. A few light showers were experienced, but they were not sufficient to cause any injury to the seed cotton.

Selection Work.

Kidney Hybrids.—All the cotton growers who are situated in the Sigatoka river valley will be issued with seed from New Guinea Kidney cottons during the season 1928–29. Seed from the increase plots of K.11 will be kept in the vicinity of the Experiment Station.

K. 8 will be given out to a community at the head of the river, K. 3 type to a community situated centrally between two ranges, while K. 1 is to be given to those who are situated between the Station and the mouth of the river. Sea Island Cotton is to be neither grown nor ginned in the Sigatoka district, and an Inspector who has recently been appointed for the purpose will insure that all the Sea Island cotton of the district has been uprooted and burnt before the new variety is planted.

Work on selections has of necessity been somewhat rushed, and seed is being distributed from increase plots a little prematurely. This has been brought about by the small demand for Sea Island cotton in the home markets, and the urgent necessity to increase the output in order to bring down our overhead costs on the crop and to hold the interest of native growers.

During September of last year lint samples from four plants were sent to England for spinning tests, and the results obtained were sufficiently satisfactory to warrant a continuance of the selection work. The lint from all samples averaged $1\frac{3}{16}$ inches in length and

was valued at 14¼d. per lb. (by the courtesy of Messrs. Wolstenholme and Holland).

Second Year Selections.—The four single plants—namely, K.3-1, K.3-2, K.8-1 and K.8-2—were planted in progeny rows and isolated from other cotton.

Owing to continuous rains and an indifferent seed bed, these plants made only moderately good germination. Careful rogueing was carried out on all selections before they had reached the flowering stage. An analysis of these cotton samples was made and the ginning percentages were taken from 100-grm. lots in each case. The result of these tests is given below.

Number.	*Weight of 100 Seeds (grms.)*	*Lint Index.*	*Ginning Per-centage.*	*Number of Bolls per lb.*	*Mean Lint Length (mms.).*	*Number of Plants.*	*Yield per Plant (lb.).*	*Yield per Acre (lbs.).*
K.3-1..	12·74	7·02	37·00	110·03	29·0	90	·566	821
K.3-2..	14·07	7·47	36·00	82·30	31·0	76	1·236	1,794
K.8-1..	14·23	7·96	33·97	83·90	28·5	117	·538	781
K.8-2..	12·93	7·02	34·50	84·60	28·9	88	·795	1,154

NOTE.—Picking has not been completed on any of the above selections, and it is estimated that the yields of them all will be increased by at least 25 per cent.

K.3-2 and K.8-2 have kept remarkably true to type and are 100 per cent. free-seeded in both cases, while K.3-1 and K.8-1 have shown a slight deviation from their parents, both being inclined to produce conglomerate seeds. These two will be given out with the bulk seed during the coming season, and the former two will be sown on increase plots occupying an isolated position at the Experiment Station. These have supplied sufficient seed for 10- and 5-acre plots respectively.

Picking Tests.—Picking tests made on the progeny row selections at Koromumu resulted in the best picker reaching a total weight of 80 lbs. seed cotton in a ten-hour day, but at the Station, where the crop was somewhat lighter, the highest tally per day was 60 lbs. as against 27 lbs. on a moderately good crop of Sea Island.

SEA ISLAND.—The seed from the six plants selected last year was planted out in progeny rows on an isolated plot at Lawaqa, and that obtained from the two best rows (S.17 and S.25) was planted around them on increase plots. Unfortunately the portion of the field upon which the selected plants were sown was slightly lower than the remainder, and consequently during the five months of heavy and

continuous rains the plants suffered badly from wet feet, and their growth was stunted to such an extent that it was decided to discontinue the selection work and to issue seed for propagation next year from the bulk lot only. This will be given out to a few good cultivators who occupy isolated positions in the Lautoka district, and should it be decided to continue the growing of the Sea Island variety in this Colony, the above-mentioned seed would form the nucleus for further selection work in the coming year.

Varietal Tests.

The tests were conducted on similar lines to those indicated in my last report, the only difference being that the area set aside for the purpose was divided into $\frac{1}{4}$-acre instead of $\frac{1}{2}$-acre plots in order to make room for a few more varieties.

Eight plots of five of the main varieties, each measuring $\frac{1}{40}$ acre, were arranged on the chessboard system as a check against soil variation.

Results obtained from Varietal Tests.

Plot Number.	*Area (Acre).*	*Variety.*	*Date Planted.*	*First Picking Date.*	*Cultivations.*	*Yield per Acre (lbs.).*
1 ..	¼	Sudan Sakel	7/11/27	25/4/28	5	298
2 ..	¼	Sea Island	7/11/	5/4/	5	790
3 ..	¼	Tanguis	7/11/	24/5/	6	412
4 ..	¼	Egyptian Sakel	8/11/	1/5/	5	274
*5 ..	¼	K.8	10/11/	24/5/	6	1,012
6 ..	¼	K.3	8/11/	4/5/	4	790
7 ..	¼	Meade	8/11/	16/4/	4	518
8 ..	¼	K.1	11/11/	4/7/	5	728
9 ..	¼	Tanguis	11/11/	5/5/	5	346
10 ..	¼	K.8	11/11/	3/5/	4	772
11 ..	¼	Meade	11/11/	27/4/	5	504
12 ..	¼	Sudan Sakel	10/11/	20/4/	4	270
†13 ..	¼	Kidney Ratoon	20/11/26	6/7/	5	710
‡14 ..	¼	Kidney Ratoon	20/11/26	13/7/	4	1,000
15 ..	¼	K.3	10/11/27	20/4/	5	796
16 ..	¼	Tanguis	9/11/	5/5/	5	670
17 ..	¼	K.1	9/11/	12/7/	4	696
18 ..	¼	Sea Island	9/11/	5/4/	4	1,141
19 ..	¼	Egyptian Sakel	9/11/	12/4/	4	396
20 ..	¼	Sea Island	9/11/	5/4/	4	1,228

* Plants in this plot were topped during the second week in April and pickings are not complete.

† This plot was ratooned to ground level.

‡ Pruned to 3 feet 6 inches of ground level.

PLOTS 21 AND 22 (CHESSBOARD PLOTS).

(Averages from Eight $\frac{1}{10}$-Acre Plots.)

Variety.	*Area (Acre).*	*Date Planted.*	*Date of First Picking.*	*Culti-vations.*	*Yield per Acre (lbs.).*
Sudan Sakel ..	$\frac{1}{5}$	6/12/27	3/5/27	5	245
Sea Island ..	$\frac{1}{5}$	,,	5/5/27	5	812
Egyptian Sakel ..	$\frac{1}{5}$	,,	5/5/27	5	247
K.3	$\frac{1}{5}$	,,	5/7/28	5	865
Tanguis	$\frac{1}{5}$	,,	6/7/28	5	472

RESULTS OF WEEKLY FLOWER COUNTS MADE ON TWO AVERAGE PLANTS OF ALL VARIETIES.

Plot.	*Variety.*	*Plant Number.*	*Weeks.*	*Flower shed-ding due to Tipworm (per cent.).*	*Flower Shed-ding due to Pink Boll-worm and Other Causes (per cent.).*
1 ..	Sudan Sakel	1	30	·08	28·0
		2	30	1·20	42·4
2 ..	Sea Island	1	30	—	16·3
		2	30	·05	15·0
3 ..	Tanguis	1	24	—	47·5
		2	30	—	70·0
4 ..	Egyptian Sakel	1	30	·19	36·2
		2	30	·27	38·8
5 ..	K.8	1	10	—	5·2
		2	10	—	6·4
6 ..	K.3	1	30	—	21·6
		2	30	—	20·8
7 ..	Meade	1	32	2·00	22·3
		2	32	1·40	23·6
8 ..	K.1	1	30	·23	23·0
		2	28	—	20·1
13 ..	Local Kidney	1	14	·22	12·0
		2	14	—	8·2
18 ..	Sea Island	1	32	·11	23·1
		2	32	—	17·5

The above results are fairly significant.

With the exception of local Kidney, the shedding due to Pink Bollworm was practically nil.

Sea Island.—Up to the present date Sea Island has given the highest yield. It reached maturity earlier than the Kidney types and all pickings have now been completed on it. During May 25 per cent. of the crop was damaged by rain.

Kidney Hybrids (from New Guinea).—These hybrids and the local Kidney cotton reached maturity at a much later date than any of the other varieties. Pickings have not yet been completed from any of the Kidney types, and it is estimated that the yield from all of the plots will be increased by at least 25 per cent. The bolls opened well and the lint, which was of moderately good quality, was easily picked.

Sakel.—Both Egyptian and Sudan strains were badly attacked by *Bacterium malvacearum*, which, together with the late rains, caused them to shed very badly. The variety is not considered to be suitable for the local climatic conditions.

Tanguis.—This variety was also attacked by *Bacterium malvacearum*. It put on a large crop which it shed immediately after flowering. All plants put on an excess of wood and had to be cut back, and on this account were later in reaching maturity than would otherwise have been the case. There is another picking to be gathered from the top crop which should increase the yields of all plots by at least 30 per cent.

Meade.—Meade was attacked by *Earias fabia* early in the season. It matured during the wet months and bolls failed to open well. It is considered unsuitable for this climate and further experiment with it will be discontinued.

Time of Planting and Spacing Tests on Sea Island.

The above experiment was carried out on similar lines to those described in my previous report. Three ¼-acre plots, one of each being planted during the middle of November, December and January, were planted with rows 6 feet apart, and an additional three were planted on the same dates with rows 5 feet apart. Plants were thinned out to the following spacings: (*a*) 2 feet 3 inches; (*b*) 3 feet 6 inches; (*c*) 4 feet 6 inches; and (*d*) unthinned.

The results obtained are not considered to be significant. The unthinned rows gave the best yield, but had the whole plot been planted with unthinned rows, it is thought that a large percentage of boll rot would have been brought about, which would probably have reduced the yield by more than half; as it was, the unthinned rows had spaced ones on either side of them which allowed the sun to penetrate, and the percentage of boll rot on them was not particularly heavy.

PLOT No. 23.

Row.	Spacing.	Date Planted.	Number of Plants.	Yield per Acre (lbs.).	Means (lbs.).
1 ..	5 feet×3 feet 6 inches	16/1/28	45	143	123·5
2 ..	Unthinned	,,	660	260	214·5
3 ..	5 feet×2 feet 3 inches	,,	65	169	130·0
4 ..	5 feet×4 feet 6 inches	,,	35	78	68·2
5 ..	Unthinned	,,	880	169	—
6 ..	5 feet×4 feet 6 inches	,,	36	78	—
7 ..	5 feet×2 feet 3 inches	,,	66	143	—
8 ..	Unthinned	,,	1,210	273	—
9 ..	5 feet×4 feet 6 inches	,,	39	65	—
10 ..	5 feet×2 feet 3 inches	,,	69	78	—
11 ..	Unthinned	,,	660	156	—
12 ..	5 feet×4 feet 6 inches	,,	39	52	—
13 ..	5 feet×3 feet 6 inches	,,	48	104	—

PLOT No. 24.

Row.	Spacing.	Date Planted.	Number of Plants.	Yield per Acre (lbs.).	Means (lbs.).
1 ..	5 feet×3 feet 6 inches	16/12/27	46	143	156·00
2 ..	Unthinned	,,	1,265	260	364·00
3 ..	5 feet×2 feet 3 inches	,,	64	208	294·60
4 ..	5 feet×4 feet 6 inches	,,	35	143	198·25
5 ..	Unthinned	,,	1,410	481	—
6 ..	5 feet×4 feet 6 inches	,,	36	221	—
7 ..	5 feet×2 feet 3 inches	,,	65	247	—
8 ..	Unthinned	,,	1,100	481	—
9 ..	5 feet×4 feet 6 inches	,,	39	208	—
10 ..	5 feet×2 feet 3 inches	,,	68	429	—
11 ..	Unthinned	,,	766	234	—
12 ..	5 feet×4 feet 6 inches	,,	38	221	—
13 ..	5 feet×3 feet 6 inches	,,	48	169	—

PLOT No. 25.

Row.	Spacing.	Date Planted.	Number of Plants.	Yield Per Acre (lbs.).	Means (lbs.).
1 ..	5 feet×3 feet 6 inches	16/11/27	49	572	533·0
2 ..	Unthinned	,,	654	767	1,014·0
3 ..	5 feet×2 feet 3 inches	,,	74	702	728·0
4 ..	5 feet×4 feet 6 inches	,,	40	468	663·0
5 ..	Unthinned	,,	604	1,027	—
6 ..	5 feet×4 feet 6 inches	,,	39	481	—
7 ..	5 feet×2 feet 3 inches	,,	74	676	—
8 ..	Unthinned	,,	498	1,339	—
9 ..	5 feet×4 feet 6 inches	,,	39	910	—
10 ..	5 feet×2 feet 3 inches	,,	68	806	—
11 ..	Unthinned	,,	544	923	—
12 ..	5 feet×4 feet 6 inches	,,	40	793	—
13 ..	5 feet×3 feet 6 inches	,,	45	494	—

PLOT No. 26.

Row.	Spacing.	Date Planted.	Number of Plants.	Yield per Acre (lbs.).	Means (lbs.).
1 ..	6 feet×3 feet 6 inches	16/1/28	44	231	231·0
2 ..	Unthinned	,,	1,112	297	418·0
3 ..	6 feet×2 feet 3 inches	,,	64	253	249·3
4 ..	6 feet×4 feet 6 inches	,,	35	187	183·3
5 ..	Unthinned	,,	436	495	—
6 ..	6 feet×4 feet 6 inches	,,	38	198	—
7 ..	6 feet×2 feet 3 inches	,,	55	253	—
8 ..	Unthinned	,,	802	462	—
9 ..	6 feet×4 feet 6 inches	,,	37	165	—
10 ..	6 feet×2 feet 3 inches	,,	60	242	—
11 ..	6 feet×3 feet 6 inches	,,	45	231	—

PLOT No. 27.

Row.	Spacing.	Date Planted.	Number of Plants.	Yield per Acre (lbs.).	Means. (lbs.).
1 ..	6 feet×3 feet 6 inches	16/12/27	41	154	253·0
2 ..	Unthinned	,,	719	627	715·0
3 ..	6 feet×2 feet 3 inches	,,	44	198	370·0
4 ..	6 feet×4 feet 6 inches	,,	35	176	282·0
5 ..	Unthinned	,,	765	649	—
6 ..	6 feet×4 feet 6 inches	,,	38	363	—
7 ..	6 feet×2 feet 3 inches	,,	68	363	—
8 ..	Unthinned	,,	800	869	—
9 ..	6 feet×4 feet 6 inches	,,	41	308	—
10 ..	6 feet×2 feet 3 inches	,,	69	550	—
11 ..	6 feet×3 feet 6 inches	,,	44	352	—

PLOT No. 28.

Row.	Spacing.	Date Planted.	Number of Plants.	Yield per Acre (lbs.).	Means (lbs.).
1 ..	6 feet×3 feet 6 inches	16/11/27	54	847	896·5
2 ..	Unthinned	,,	865	1,628	1,672·0
3 ..	6 feet×2 feet 3 inches	,,	71	1,144	1,239·3
4 ..	6 feet×4 feet 6 inches	,,	38	891	924·0
5 ..	Unthinned	,,	788	1,595	—
6 ..	6 feet×4 feet 6 inches	,,	39	913	—
7 ..	6 feet×2 feet 3 inches	,,	73	1,276	—
8 ..	Unthinned	,,	632	1,793	—
9 ..	6 feet×4 feet 6 inches	,,	44	968	—
10 ..	6 feet×2 feet 3 inches	,,	67	1,298	—
11 ..	6 feet×3 feet 6 inches	,,	47	946	—

Cotton Crosses.

Various crosses made during last season at the Station, together with some kindly sent out for trial by Dr. Bancroft of Queensland, were planted out in single lines on a ¼-acre plot set aside for the purpose.

All of the hybrids sent over from Queensland were a complete failure. Those which were not killed off by "Black Arm" were severely infested with jassid and produced practically no crop. A brief description of the other hybrids is given below.

Acala × *Sea Island.*—The habit of growth was somewhat similar to that of Sea Island. The leaves were mostly smooth, one plant in five possessed Acala characters with slightly hirsute leaves. The flowers resembled those of Sea Island, but the corolla was a paler yellow and the guide marks at the base were much less vivid. The seeds had a heavy greenish fuzz. Bolls were large and about 25 per cent. five-locked. The lint, which was fine and silky, averaged 38 mm. in length.

Meade × *Acala.*—These hybrids resembled Acala in habit of growth. The leaves were broad, dull green in colour, and very hirsute. The flowers, a pale yellow in colour with no basal coloration or guide marks, opened very fully. Seeds were covered with a short white fuzz which gave them a greyish appearance. The fuzz was less dense than that of Acala and the cotton should be a fairly easy ginner. Bolls were very large and about 27 per cent. five-locked. The lint, which averaged about 35 mm. in length, was of good quality and free from nep.

Sea Island × *Acala.*—The plant resembled Sea Island in habit of growth, but the leaves were much broader and of a dull green colour, non-hirsute. Flowers were pale yellow and showed slight coloration at the base of the corolla, which did not vary. Bolls were three-, four- and five-locked. Seeds possessed a bright green fuzz. The lint was creamish brown in colour, silky in texture, and measured 30 mm. in staple length.

Sea Island × *Meade.*—These plants showed slight jassid-resistant properties, and their habit of growth somewhat resembled that of Sea Island. The leaves were non-hirsute, very broad, and dark green in colour. Each plant was very uniform. Flowers were pale yellow with slight basal markings. Bolls were three-, four- and five-locked (mostly four-locked). The seed was of a chocolate colour with a large white tuft at the apex. It was slightly larger than, though very similar to, Meade. The lint, which was very silky, sparse, and difficult to distinguish from that of Sea Island, measured 52 mm.

PLOT No. 29.

Variety.	*Weight of 100 Seeds (grms.).*	*Lint Index.*	*Ginning (per cent.).*	*Average Lint Length. (mms.).*	*Number of Plants.*	*Yield per Plant (lbs.).*	*Calculated Yield per Acre (lbs.).*
Sea Island × Meade ..	13·03	3·47	22·5	52·0	44	51	2,103·5
Acala × Sea Island ..	10·95	7·83	29·5	38·0	9	10	2,016·4
Meade × Acala	11·31	7·44	32·5	35·0	93	51	994·52
Caravonica from Noumea	16·57	7·70	32·7	28·6	3		1,815

Time of Flowering and Bolling Averages.—Four plants from each variety were labelled, and daily observations were made. Five squares on each plant were marked by coloured ribbons, and the results given below are the averages taken from twenty marked squares in each variety.

Variety.	*Planting to Squaring (Days).*	*Squaring to Flowering (Days).*	*Flowering to Maturity (Days).*	*Remarks.*
Sudan Sakel ..	37	21	52	
Sea Island ..	37	21	63	
Tanguis	37	28	82	
Egyptian Sakel ..	36	21	52	
K.8 .. .. S.I. 42	S.I. 42	25	59	There were two types: S.I.=Sea Island, and K=Kidney type.
K.8 .. .. K.104	K.104	52	80	
K.3	102	55	75	
Meade	36	17	49	
K.1	101	60	83	
Kidney Ratoon ..	128	31	85	128 days from ratooning.

PESTS AND DISEASES.

Jassid.—Jassid was most prevalent during the months of March, April, and May, but disappeared with the advent of dry weather, and most varieties which had suffered from it made rapid recovery. Tanguis was found to be resistant.

Pink Bollworm (*Platyedra gossypiella*).—Very little damage was caused by this pest during the season under review. It was most probably kept in check by parasites. It was more prevalent on the

local Kidney cotton than any of the other varieties, but on this variety only about 3 per cent. of the seed cotton was injured by it.

Cotton Stainers (*Dysdercus insularis*).—Until the latter part of the season stainers were kept in check by hand collection. Every three or four days small boys were sent along the rows with kerosene tins containing half a gallon of equal parts of kerosene and water, into which the stainers were shaken from the branches.

Experiments were tried out with different types of " Tree Tangle Foot " on some of the Kidney Hybrid cottons (K.8 type, which is almost a tree cotton). The " Tree Tangle Foot " imported from the United States of America was found to be the best in that it prevented all stainers that were in the nymph stage and unable to fly from reaching the cotton, and only a few of the adults were found on the bolls. This type of tangle foot is, however, too expensive to be advocated on a commercial scale as a prevention of stainers.

Trials were made with resin, local gums, linseed oil, etc. Some of these mixtures acted quite well for the first week or so, but they soon lost their tenacity.

Harlequin Bug (*Tectacoris lineola*).—These pests were also kept in check by hand collection, and did not at any time reach major proportions.

Fruit Fly (*Dacus passiflorœ*).—Despite a careful search, the fruit fly could not be found on any of the varieties this season.

Tip Worm (*Earias fabia*).—The incidence of the pest was light, and affected Meade more than it did other varieties.

Black Arm (*Bacterium malvacearum*).—This disease made its appearance on Tanguis first, and in some instances caused it to die right back. Later it attacked both strains of Sakel. Other varieties were not greatly affected by it, though a few plants from all varieties were found to be slightly affected.

Future Prospects.

Although the two past seasons have been very discouraging, and growers had at one time lost all interest in cotton growing, the prospects for the future development of the industry appear to be much brighter, and native growers of this district are quite keen to obtain seed of the new Kidney variety. It is anticipated that between 700 and 800 acres will be planted with it during the coming season, 1928–29. The estimated acreage for all the other districts is 2,000 (this will be planted with Sea Island).

Programme for 1928–29.

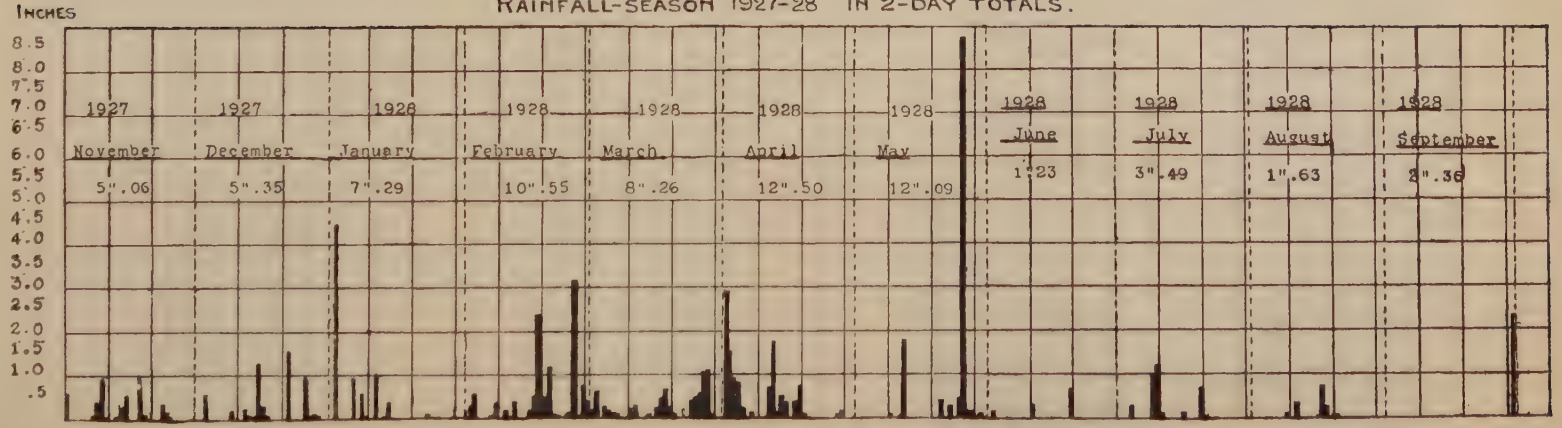
In the forthcoming season most of the time will be devoted to plant selection and breeding work with the new Kidney Hybrids, and many of the varieties grown in the varietal tests last season will be done away with. Spacing tests will be discontinued with Sea Island cotton. Experiments will be carried out with various methods of ratooning Kidney types, together with spacing and topping experiments.

Conclusion.

In conclusion I should like to express my gratitude to the Superintendent of Agriculture and the Government Cotton Inspector for much appreciated and helpful co-operation rendered by them, which greatly assisted operations on the Station. Also to my two Field Assistants, Messrs. H. V. Petly and C. M. Dass, who have both carried out their work very satisfactorily.

SIGATOKA EXPERIMENT STATION, FIJI.

RAINFALL-SEASON 1927-28 IN 2-DAY TOTALS.



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